ARMY ORDNANCE

VOL. XIII, No. 73 JULY-AUGUST, 1932

Economy and the Army
By Charles G. Mettler

The Disappearing Gun Carriage
By Maj. Gen. William Crozier

Mechanization in Our Army Today
By John K. Christmas

Navies and the Airplane
By Fred. H. Wagner

Munitions Contracts in the Next War
By P. J. O'Shaughnessy

The Defense Act–It Must Be Preserved
An Editorial

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

Combat Car T-3—Accepted after Thorough tests by the Ordnance Department for Service in the U. S. Army

AGILITY - STAMINA - POWER

AND

DEPENDABILITY

COMBAT CARS - TANKS

MANUFACTURED UNDER PATENTS

OWNED AND CONTROLLED BY

U. S. WHEEL TRACK LAYER CORP.

Linden, N. J.

PATENTEES

J. WALTER CHRISTIE
LEONARD ANDERSON
ROBERT G. ANDERSON
AUSTIN M. WOLF

AOA

ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

Published by the Army Ordnance Association, Suite 805, The Mills Building, Washington, D. C. Editor: L. A. Codd.
Authors alone are responsible for statements made and opinions expressed in their respective articles. Specially written articles on appropriate subjects are solicited.

Issued Bimonthly. Single Copy 75c.
Subscription rate: Continental U. S. $4.50 per annum, foreign $5.00, in advance. Entered as second-class matter August 14, 1920, at the Post Office at Washington, D. C., under the Act of March 3, 1879. Additional second class entry at the Post Office at Richmond, Va.

Volume XIII | JULY-AUGUST, 1932 | No. 73

CONTENTS

Page

Col. T. C. Dickson, Ord. Dept., U. S. A. - - - - - Frontispiece
Economy and The Army - - - - - By Charles G. Mettler 7
Studies in Steel, II. The Glow of Molten Steel - - - - - By John P. Mudd 10
Mechanization in Our Army Today - - - - - By John K. Christmas 11
The Disappearing Gun Carriage - - - - - By Maj. Gen. William Crozier 18
Munitions Contracts in the Next War - - - - - By P. J. O'Shaughnessy 23
Navies and the Airplane - - - - - By Fred H. Wagner 29
Styles in Small Arms Projectiles - - - - - By Thomas H. Green 36
Principles of Firearms Identification - - - - - By Charles O. Gunther 40
Editorial - - - - - 44
With the Tanks at Shanghai—Colonel Dickson's Great Service—The Method of Defense is not Fixed—A Levy on War Profits—Ordnance Reserve Training in Demand—Abolitionists in a New Role—Government Competition with Business—The National Defense Act, It Must Be Preserved.
Association Affairs - - - - - 48
Postponement of the Aberdeen Meeting—Biennial Election of Officers—Boston Post—Annual Meeting of Bridgeport Ordnance District—Membership Committee—The New Cover Design—Necrology—New Members.
Communications - - - - - 50
Forcing Resistance of Bullets as Related to Velocity—The Ordnance Job at Mehun-sur-Yevre—Design of the Gun—Howitzer Carriage, T2—Ordnance Service.
Professional Notes - - - - - 53
Firepower of the Infantry—Railway Artillery Proves Value of Mobility—New Type Gas Mask—Perfecting Long Range Artillery Fire.
Book Reviews - - - - - 55
Index of Advertisers - - - - - 67

"Certain patriotic citizens have realized the importance of adequate industrial preparation and have voluntarily organized to assist in this work. The Army Ordnance Association comprises such a group, upon which the War Department leans heavily in carrying on the many activities incident to this type of preparation."

Frederick H. Payne, The Assistant Secretary of War.

The Army Ordnance Association

THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

The Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Ordnance Department.

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

OFFICERS

President: BENEDICT CROWELL, Cleveland, Ohio
1st Vice-President: WILLIAM W. COLEMAN, Milwaukee, Wis.
2nd Vice-President: WILLIAM C. SPRUANCE, Wilmington, Del.
Treasurer: CHAS. ELLIOT WARREN, New York, N. Y.
Counsel: JOHN ROSS DELAFIELD, New York, N. Y.

DIRECTORS

SAMUEL MCROBERTS, New York, N. Y.
ROBERT P. LAMONT, Chicago, Ill.
FRANK A. SCOTT, Cleveland, Ohio
C. L. HARRISON, Cincinnati, Ohio
JAMES L. WALSH, New York, N. Y.
BRUCE CORNWALL, San Francisco, Calif.
CHARLES H. TENNEY, Springfield, Mass.
HARRY SCULLIN, St. Louis, Mo.
PLINY E. HOLT, Stockton, Calif.
R. M. DRAVO, Pittsburgh, Pa.
JOHN C. JONES, Philadelphia, Pa.
E. A. MULLER, Cincinnati, Ohio
C. C. WILLIAMS, Washington, D. C.
JOHN S. SEWELL, Birmingham, Ala.

Executive Secretary: L. A. CODD
Executive Offices: Mills Building, Pennsylvania Avenue at 17th Street, Washington, D. C.

Local Posts of the Association

THERE are eleven local posts of the Association organized for the more intimate professional contact of members in the achievement of the purposes of the organization. All Association members may affiliate with posts of the locality in which they reside.

New York, Established June 15, 1921

President: Samuel McRoberts. 1st Vice-President: H. B. Machen. 2nd Vice-President: F. W. Roller. 3rd Vice-President: J. E. McNary. 4th Vice-President: Robert Boettger. Executive Committee: The Officers and Charles Elliot Warren, John Ross Delafield, C. W. Rice, T. A. Morgan, James L. Walsh and N. F. Ramsey. Treasurer: C. Wingate Reed. Secretary: Charles G. Mettler, 39 Whitehall Street, New York City.

California, Established October 17, 1923

President: Pliny E. Holt. Vice-President: Charles N. Black. Directors: D. C. Jackling, W. H. Oliver, L. F. Fuller, J. J. Thomas, M. M. Mitchell, Bruce Cornwall, Theodore J. Hoover, Samuel Kahn. Secretary-Treasurer: C. C. Harshman, 58 Sutter Street, San Francisco, Calif.

Chicago, Established May 3, 1924

President: A. K. Hamilton. Vice-President: F. A. Lorenz. Directors: E. J. Buffington, R. P. Lamont, E. A. Russell, W. C. Young, W. R. Wright, O. H. Wurster. Treasurer: W. H. Damon. Secretary: Vacant.

Boston, Established June 30, 1925

President: R. F. Whitelegg. Vice-President: James S. Smyser. Directors: Everett Morss, Edward F. Miller, R. J. Thanisch, Charles E. Cowdrey, Clark S. Robinson. Treasurer: Archibald McMillan. Secretary: Roger Taylor, 89 Broad Street, Boston, Mass.

Washington, Established November 18, 1925

President: Earl McFarland. Vice-Presidents: Henry P. Erwin, Chas. E. Munroe. Directors: C. C. Williams, Robert P. Lamont, Swagar Sherley, Howard Bruce, Geo. B. McClellan, Fred E. Wright, Leroy Hodges. Treasurer: C. E. McRae. Secretary: H. A. Strong, Munitions Building, Washington, D. C.

Cincinnati, Established December 10, 1925

President: E. A. Muller. Vice-President: S. M. Rowe. Directors: C. L. Harrison, C. W. Verity, W. C. James, J. T. Faig, A. H. Pugh, R. T. Hazelton, F. V. Geier, E. E. Stokes. Secretary-Treasurer: Chas. A. Walker, 730 Southern Railroad Building, Cincinnati, Ohio.

Philadelphia, Established December 9, 1926

President: Philip H. Gadsden. Vice-Presidents: William C. Spruance, Charles Z. Tryon. Directors: J. W. Rawle, Thomas S. Gates, William D. Burk, John P. Sykes, J. W. Robbins, J. L. Poultney. Secretary-Treasurer: W. L. Clark, 1205 Gimbel Building, Philadelphia, Pa.

St. Louis, Established January 18, 1927

President: Harry Scullin. Vice-President: E. D. Campbell. Directors: J. M. Kurn, J. W. Jarboe, A. J. Davis, E. D. Nims, M. E. Singleton, W. F. Carter, J. M. Olin, H. I. Finch. Treasurer: Carter Bliss. Secretary: L. J. Dillon, Southwestern Bell Telephone Building, St. Louis, Mo.

Pittsburgh, Established February 24, 1927

President: Ralph M. Dravo. Vice-Presidents: Taylor Allderdice, George G. Crawford. Directors: O. W. Buenting, Frank B. Bell, H. A. Gidney, C. W. Heppenstall, Julian Kennedy, E. T. Whiter. Treasurer: G. M. Sixsmith. Secretary: Fred A. McMahon, 1014 Diamond Bank Building, Pittsburgh, Pa.

Milwaukee, Established September 26, 1928

President: W. W. Coleman. Vice-President: Eric H. Lichtenberg. Directors: James G. Cowling, Herbert V. Kohler, Roger Sherman Hoar. Secretary-Treasurer: C. W. Lauman, Bucyrus-Erie Company, Milwaukee, Wis.

Birmingham, Ala., Established December 3, 1930

President: Theodore Swann. Vice-President: George Morrow, Jr. Directors: Robert Ingalls, Thomas E. Kilby, S. F. Clabaugh, George Woodruff, C. H. Menger, Herbert Stockham, Landers Sevier. Treasurer: Ralph E. Parker. Secretary: D. N. Hauseman, 250 Federal Building, Birmingham, Ala.

Col. T. C. Dickson, Ord. Dept., U. S. Army

Commanding Officer, Watertown Arsenal, Who Will Retire from Active Military Service September 30, 1932.

ARMY ORDNANCE

VOL. XIII JULY-AUGUST, 1932 No. 73

Economy And The Army

A Reply to Hoffman Nickerson in the Last Issue of this Journal

By Charles G. Mettler*

IN these days of diminishing profits in industry, of increasing taxes on many commodities, and of dwindling treasury receipts from all sources, a large number of legislators, Army officers and nationally-minded citizens are considering very seriously how we may reduce in the best way the cost of national defense along with and proportionately to the other necessary functions of the United States Government. Colonel Hoffman Nickerson's article in the May-June, 1932, number of ARMY ORDNANCE is one of these serious considerations. The splendid contributions of this officer and author to military literature over many years as well as the position of his long article in ARMY ORDNANCE makes the correction of some of his statements highly important to the Army and the country, particularly in these times when clear thinking and accurate conclusions are so much demanded.

Taking up his insurance metaphor, if it be a metaphor, I am not so sure he has covered all the insurance which many of our people consider covered by our national defense scheme. These are some of the items that we are supposed to be insured against:

(a) Against being waked up in the middle of our business programs and ordered out into the mud, dirt, barbed wire and misery of war to fight a foreign enemy.

(b) Against being subjected to another economic waste of world wealth that will require another quarter-century to regain.

(c) Against domestic violence by organized minorities.

(d) Against insult and mistreatment on occasions of our visits to other nations of the world.

(e) Against piracy and other violence on the high seas and in the less civilized and less organized areas of the world.

(f) Against loss of the gains of civilization in art and science and in the improvement of the standards of life accomplished in the long periods of peace.

No nation regardless of its wealth can afford to insure one hundred per cent, as Colonel Nickerson so aptly points out, but any nation can insure in a certain proportion to its wealth against such calamities. Our Congress, upon recommendation of the President, sets the amount of insurance we will carry, and is very careful in its consideration of the rate that is paid for this insurance.

There are many ways of reducing the cost of fire insurance and they are in some measure analogous to the ways of reducing national insurance premium. Among these are: (a) Fire-proof construction; (b) Automatic sprinkler systems; (c) Fire extinguishers located strategically; (d) Paid fire departments, always ready with the best fire apparatus and water systems; (e) Volunteer fire departments and the like; (f) Elimination of neighborhood hazards.

A FIREPROOF construction throughout materially reduces the rate. Our political structure and our economic structure have not been so soundly built. The Civil War, the many riots, strikes and interior difficulties, the economic collapse, the prohibition difficulties, the rise of communism and racial and religious arguments remind us that we are not immune from interior dangers. We are not fireproof.

We have our critical areas to protect. Our statesmen certainly would not countenance the removal of all troops from Fort Myer, Fort Meade and Fort Washington when streets of the Capital City were filled with a partly organized and discontented minority, however small. We would never forgive them, if the Government were paralyzed and records destroyed, no matter how short a time such a condition existed. This critical spot of our country requires high protection. Old capitals of the world were walled and inner walled and armament bristled upon their battlements. The newer capitals retain the best national troops within a reasonable radius. A nation cannot be wholly built of fireproof materials but a democracy is sometimes less fireproof than an absolute monarchy.

All nations try to maintain an automatic sprinkler system through local police, local constabulary, and territorial troops such as our National Guard. These elements we have consistently maintained at fairly high standards. At strategic points over the nation, the National Government has located its own troops to take care of local failures. These troops are frequently changed. They are not allowed to become a part of any community.

The nation maintains a permanent force under its direct charge, a small one to be sure, but a well equipped one. It consists of the Regular Army, the Navy and the Marine Corps. It supplements this force by reserves, officered and organized under a definite plan, the officers trained under a definite policy, by members of the regular forces which are augmented in officer personnel for this purpose.

The states each maintain their organized troops under the name of the National Guard. In case the National Guard can be spared by the states under favorable local conditions, it becomes also a reserve to the national forces. Being organized and manned at all times, it becomes the most important national reserve. The regular forces are augmented in officer personnel to train these troops in accordance with national doctrines. In certain cases, the National Guard can be used more economically than the reserves and has been

*Executive Officer, New York Ordnance District. Formerly Assistant Military Attaché, American Embassy, London, England. Lieutenant Colonel, Ordnance Department, U. S. Army.

used quickly and effectively by the nation. However, the state relationship of this force must not be overlooked, even though it is available under the law to the National Government.

It is the function of the Regular Army to keep in working order the whole scheme by which the National Guard and reserves are recruited, trained in one doctrine, and prepared to fit into a single workable organization with maximum speed and efficiency. Its function is also to be prepared to equip, quarter, transport and supply the daily varying enormous requirements of this vast force from the moment of its assembly until it shall have accomplished its purpose in whatever area it may become necessary to use it. Its mobilization is contemplated as follows:

The expansion of the Regular Army to 24,000 officers and 450,000 enlisted men; the expansion of the National Guard to 24,000 officers and 480,000 enlisted men; the expansion of the Organized Reserves to approximately 106,000 officers and 2,000,000 enlisted men; the development of the necessary overhead functions to direct and supply this force. The total would reach approximately 154,000 officers and 3,000,000 enlisted men. Should this force be inadequate to meet the emergency, other phases of expansion are provided for up to a point where the whole power of the nation is brought to bear upon the issue to be decided by war.

COLONEL NICKERSON is manifestly unfair in his rather loose distribution of regular officers in proportion to the present enlisted strength of the Regular Army. However important the enlisted force may be for its particular functions, it does not play a part at all comparable to the officer's part in the organization, training, mobilization and direction of the national military organization for war. There is no comic opera feature in this scheme. There is no padding of the officer's grades with useless persons or useless rank. The scheme is definite, workable, and in operation under a logical legal procedure with its personnel definitely assigned and functioning continuously.

The spread of the regular officers of the reduced Regular Army as now provided for in appropriations, varies to meet current needs. The studies made for the National Defense Act of the proper peace-time requirements are available and indicate the most logical distribution of the United States forces for safety. The available figures determined by our best military experts about 1920 to 1922, are indicated below:

Continental United States	3,584	officers	80,022	men
Panama	703	"	13,778	"
Hawaii	980	"	19,427	"
Philippines	638	"	4,211	"
China	57	"	1,135	"
Porto Rico	63	"	1,593	"
Alaska	19	"	596	"
Schools	1,985	"	12,262	"
Coast Defense	733	"	10,933	"
National Guard	732	"	800	"
Organized Reserves	716	"	900	"
Reserve Officers Training Camps	756	"	1,200	"
Overhead Administration and Staff Study	3,301	"	15,147	"
	14,267		162,004	

To provide additional officers and men for all the semimilitary and nonmilitary activities not provided for in the above distribution, Congress fixed the normal strength of the U. S. Regular Army in the National Defense Act at 18,000 officers and 280,000 men. Its actual strength as provided for in the last fiscal year by appropriation amounted to 12,000 officers and 118,500 enlisted men. Due to the present financial condition of the country and the state of the National Treasury, Congress recently deliberated over a further reduction of 2,000 officers during the present fiscal year, without changing the military, semimilitary or nonmilitary duties required of the War Department. Fortunately this was not done.

The variation between the normal strength and the present condition, and between the defense requirements established by the nation's military experts and the proposed strength, indicates that the nation is inclined to take great risks in times of depression; that it has seriously considered borrowing heavily upon its insurance to meet present day financial conditions.

For the National Guard and Reserve forces with their feeding elements, our military experts fixed upon the following essential peace-time numbers to provide for war expansion:

National Guard	16,324 officers	250,000 men
Organized Reserves	80,182 "	125,000 "
Reserve Officers Training Corps		120,000 students
Citizens Military Training Camps		50,000 "

Referring back to the allowances of regular officers, there is for the National Guard approximately one regular officer and one regular enlisted man for each 360 members; for the Organized Reserves, approximately one regular officer and one enlisted man for each 300 members; for the college and university instruction in the Reserve Officers' Training Corps, approximately one officer and two enlisted men for each 160 students; and for the Citizens' Military Training Camps, no allowances of officers or enlisted men.

The present figures of regulars to guard and reserve, or of guard and reserve strength, are not available, but there is a thin spread for the officers and enlisted men of the Regular Army which keeps those assigned to such duty more than occupied day time and evening. It is hard duty. One does not find a demand for it among the regulars. However, one does find the results of the regular training in the orderly assembly of guard and reserves into camp and the order of excellence obtained by the organizations under instruction.

On the other hand, the reserves are inexpensive. Those on the inactive list have had a considerable amount of training and are by no means to be disregarded in the general scheme. Those on the active list are getting information that would require many months to impart after an emergency arose and are ready to be a definite part of any colossal machine which may be constructed in time of danger. This machine should and will use all of our available power to protect the country and to establish its policies if it be necessary to build it.

The scheme is correct. There is no cheaper one to provide for the national security that anyone has been able to devise. It is flexible as indicated by the way Congress has increased or decreased its cost as the conditions at home and abroad have demanded. It is better than any scheme shown by any foreign country. The task of perfecting it has not been finished but there are many serious-minded officers and Congressmen and statesmen constantly observing it and correcting it. The National Defense Act is a masterpiece of legislation devised to bring all the war potential of the country to the single purpose of the support of the nation in any

crisis. Its fundamental principles should not be disturbed. On these principles, a unified and effective national defense can and will be constructed for any national emergency.

COLONEL NICKERSON has made a point of the fire insurance metaphor, and emphasized the small chance of requiring a large assembly of protective force in the United States. It is indeed true that the neighborhood risk of this country has been low over many years. The distances from dangerous structures have been long and hard to traverse. Our founders were careful to cover all the real estate from one ocean to the other, and from the Great Lakes to the Gulf of Mexico with their building. This greatly improved neighborhood conditions and prevented the erection of adjacent hazards.

In recent years we have extended our business structures far beyond the original boundaries. We have built in highly dangerous areas at great cost large edifices of American trade. Our insurance now covers much more than the original construction. We have extended our real estate holdings far into the Gulf of Mexico and across the Pacific Ocean. These new sections are by no means so free from danger as the original real estate. The rates are necessarily higher on all structures in the new areas. The changes in communication, transportation and exchange in recent years have reduced the value of our isolated position.

THERE is another phase to this matter of defense. It is not so much a question of the likelihood of requiring the enormous forces organizable in our country although the possibility cannot be denied, but the question is one of being able to produce and equip them. This ability alone is the yardstick by which the power of our country is measured by others in the family of nations. This is the real insurance. This ability should not be lessened as it is a great guarantee of peace.

Too many people assume as Colonel Nickerson does that once we have left the Philippines our commitments in the East are over and this neighborhood risk is gone. This is a serious mistake. Our liability at once becomes greater when we shall have departed from these debatable islands. All the governors of the islands and all statesmen who have studied the international effect of the proposal to free them are fully aware of the danger. Colonel Nickerson has confounded some of the economic arguments of our sugar and tobacco magnates and representatives with the military phases of this question. We must of necessity assume a greater international police policy in the East if the Philippines are freed, if not indeed a direct mandate to control them in their independence.

THERE exists also a popular idea which Colonel Nickerson has sponsored that the mobility features of new automotive equipment adapted to army use since the World War in some way reduces the requirement for officers and men in war. It does increase the horsepower available to the average soldier both for speed and battle effect, but it requires a far better trained soldier, a higher number of officers and a technique of war that is greater than the older methods of warfare. The equipment is in itself an expensive tool of war and its adoption does not cut down the expense of training or of handling, in spite of the fact that it can stand alone in the stable without water or oats or corn. The adoption of weapons of higher fire power along with and a part of the new policies of mechanization likewise creates greater individual average horsepower for battle effect, but a higher order of training in their use is required also as well as a new battle technique. The ammunition carriers and handlers are multiplied. This policy is not essentially a man-saving policy but rather a policy of increasing the effectiveness of the men available. It is too easy to say that war is changed by the advent of each new weapon. Our people like to be told new facts in a startling way. They read that the tank, the airplane, the bomb, the poison gases, the submarine, the depth bomb, the submarine mine, the radio death ray and like new things will shorten wars because no human thing can withstand their deadly effect. That is a thrill for the moment and eventually a belief. We forget that things are ever being compensated.

Let us write down now and try to remember this simple fact. Human ingenuity is as powerful in one direction as in another, in defense as in offense. No great power is useful to its full value unless it is controlled and directed by competent human hands and brains.

All the changes which we of the Army are making in the way of mobility or of increased mechanical power in battle are necessary to combat similar changes in the armies of the world, or to keep abreast of new developments which are very likely to be used by our possible enemies. Seldom, if ever, does one army excel another very much or very long in the design or use of fighting tools, nor does a superior tool enjoy its superiority very long before it is neutralized by some ingenious tool on the opposing side. In the long run, superior resources in men, materials and power, if properly used and coördinated, are likely to achieve a victory.

WHAT any country needs above all else to prevent great losses of wealth and life in war, is a superior time factor, an ability to apply men, materials and power to the problem before its opponent can do so, to apply superior force against inferior force at the earliest moment. Then wars are shortened and cost less to the world. Our defense plan provides for reducing this time factor of action. The proper manning of this plan with trained officers and men is the greatest safety feature in our scheme of national security.

Economy of national defense is served best by a continuing national plan, flexible to meet the changing conditions, but ever expandable within a reasonable time to meet the major national needs. Economy of insurance requires a balanced Regular Army, whose officers are able to keep every phase of the war plan, both military and industrial, in running order; a manned and officered National Guard in the states for instant domestic use, yet trained and available to fit into the national armies; a reserve army fully organized and largely officered, subject to call in case of need, to be filled in as required by the extent of the national emergency; and to bring the whole force of the nation into one coordinated and directed mechanism. This is provided for in the National Defense Act.

Colonel Nickerson's attack on the Defense Act and on the regular officers cannot be justified by his own reasoning in his article, but far less can he be excused for his failure to present the true facts of our national requirements, which he has shown by his previous writings are well known to him. I am inclined to the conclusion that he does not mean to be taken too seriously, but desires to develop a controversy to awaken some of us to the dangers of tampering with security. If this be his motive, he has partly succeeded.

Studies in Steel, The Essence of Ordnance

II. THE GLOW OF MOLTEN STEEL

The Second of a Series of Photographic Studies by Mr. John P. Mudd for the Midvale Company

Mechanization in Our Army Today

Recent Developments in Automotive Fighting Vehicles

By John K. Christmas*

THE automotive work of the Ordnance Department began in a small way sometime prior to the World War, but it was not until 1916, in connection with the Mexican border campaign, that commercial artillery tractors and 4-wheel-drive trucks were procured in limited numbers for use with field artillery. Tanks appeared in our Army in 1917 by virtue of our relation with the Allies, particularly the British, who originated the fighting tank in 1915. During the World War a large number of tanks of foreign design were used in the American Army, and when the Armistice was signed we had on order about 19,000 tanks for the 1919 campaign. This shows the importance then attached to the tank, a comparatively new weapon. A few armored cars were built during the World War by the Ordnance Department, but the stationary nature of the warfare in France stopped any further development, and it was not until 1928 that the development of armored cars was seriously undertaken by our service. However, the armored car may now be said to be, next to the tank, the most important mechanized vehicle with which the Ordnance Department is concerned.

Mechanization is a term which, in the military sense, refers to the use of automotive vehicles for combat purposes in contradistinction to motorization, which refers to the use of automotive vehicles for transportation purposes only and mostly other than in combat. The sole object of the British in developing the tank was by the use of tracklaying automotive vehicles to transport men and fire power *protected by armor* across the fire-swept battle area to the enemy's position, so as to decrease the enormous expenditures of men and artillery ammunition otherwise necessary to overcome the great defensive power of a modern army; a power due mainly to the modern machine gun. This basic principle underlying the development of the tank should be borne in mind, as it should and does effect the proper development of tanks and other mechanized vehicles. Since the number of tanks available during the World War, the limited knowledge of their tactical use, and their mechanical unreliability precluded the use of tank or mechanized units exclusively, the tanks were used then as accessories to the infantry assault. Post-war developments have improved the speed and reliability of tanks so that the idea of wholly mechanized combat units arose, first with the British, to be employed instead of the existing "muscle-propelled" fighting units.

Present-day mechanization takes the general form that the light, fast mechanized vehicles are used by units having the tactical missions of reconnaissance and maneuver, that is, the cavalry; while heavy, slow tanks are employed for assault purposes, that is, by the infantry units. In our Army an experimental mechanized force was first organized at Fort George G. Meade, Maryland, in 1928, and disbanded at the end of four months. With the tactical and engineering lessons of this force as a guide there was, in 1930, organized at Fort Eustis, Virginia, a second mechanized force; this force was more modernly equipped than the 1928 force, had smaller supply units, no heavy trucks and no infantry units other than a machine gun company. It was disbanded in 1931 by being made into a mechanized cavalry regiment, now stationed at Fort Knox, Kentucky. These three organizations show the development of tactical thought in mechanization from the idea of a force of all arms wholly mechanized to that of a mechanized cavalry arm, that military unit best able to capitalize the speed, fire-power protection and shock-power of light, fast, mechanized vehicles.

AT present, the work of the Ordnance Department in procuring, developing and manufacturing mechanized vehicles involves the following: tanks, armored cars, artillery prime movers, machine gun carriers, scout cars, reconnaissance vehicles and self-propelled gun mounts. The development of self-propelled mounts has been in abeyance for some time so far as the track-laying type is concerned, but the development of 75-mm. gun truck mounts on 6-wheeled trucks has recently again been undertaken; some have been described in recent issues of ARMY ORDNANCE.

(EDITOR'S NOTE: Other articles descriptive of particular elements of mechanization which have appeared in recent issues of ARMY ORDNANCE include: "The New Christie Tank, Model 1940," by C. C. Benson, Vol. X, No. 56, page 112; "A Successful Baby Tank," by Robert J. Icks, Vol. X, No. 59, page 321; "A New Weapon for Field Artillery," by G. M. Barnes, Vol. X, No. 60, page 391; "The Universal Gun and Mount T-3," by G. M. Barnes, Vol. XI, No. 63, page 187; "The Mechanized Force, U. S. Army," by Burton O. Lewis, Vol. XI, No. 66, page 429; and the series under the general title "Possibilities of the Tank," by Fred. H. Wagner, which concludes in this issue.)

The problem of the Ordnance Department is to furnish automotive combat vehicles to the fighting arms; the essential problem here lies in developing a satisfactory *chassis* having the necessary *cross-country mobility* for combat purposes. As shown in Table 1, all possible automotive vehicles may be divided into a number of basic engineering types having varying degrees of cross-country tactical mobility and of road, or strategic, mobility. While in the combat, or mechanized, vehicle the cross-country or fighting mobility is of much the greater importance, the question as to which type of chassis to select for a particular purpose must necessarily be answered after due consideration of all the factors shown in the table, such as cost, availability, and relative mobility under different conditions. However, for real combat purposes, *only the full track-laying vehicle has the practically universal tactical mobility required to replace the horse or man;* therefore, the primary problem of the Ordnance Department is to develop track-laying vehicles, and since higher speeds are required than are obtainable commercially, this development is a large problem which the Ordnance Department must handle almost entirely itself.

The World War showed enormous difficulty in procuring sufficient quantities of munitions, and as mechanized ve-

*Formerly, Chief, Automotive Section, Artillery Division, Office of the Chief of Ordnance. Captain, Ordnance Department, U. S. Army.

hicles will be required in large quantities, and are of special manufacture, it is highly important that the use of special vehicles be limited to absolute necessity and that as few different types as possible be called for. This reasoning gives priority to the development of tanks and other full track-laying mechanized vehicles. Owing to the complexity of the Ordnance Department's automotive problems, and to the limited funds available, every endeavor is made to rely on the automotive industry by using commercially available automotive units, such as engines, as far as is practicable. This policy is particularly adhered to with respect to engines, the development of which requires very special knowledge and large amounts of money. An enormous amount of development work in automotive engines is going on in the industry. But we cannot always find an engine exactly suited to our purpose because our requirements are somewhat contradictory in that the speeds demanded of our vehicles require light, high-powered engines of the passenger car or airplane type, which engines are not well suited in ruggedness to the heavy duty involved in propelling track-laying vehicles. Our greatest need is for light rugged engines of 125 to 200 b. h. p. for light tanks.

The principal work of the Ordnance Department, therefore, is concerned with the development of proper transmission, steering mechanisms, suspensions, tracks, armor plate hulls, turrets, tank guns and gun mounts. These may not appear to be very complicated problems, but when attention is invited to the fact that commercial tractors now have a maximum speed of about six miles an hour, while maximum speeds of 20 to 30 miles an hour are being demanded by our using arms, it can be seen that a serious question has been presented. In any tank the difficult things to achieve are to obtain the high speeds required with the armor protection demanded, while at the same time keeping the vehicle's weight down and providing enough room for a fighting crew. Some idea of the enormous power demanded in fast track-laying vehicles, as compared with wheeled vehicles, can be seen from Fig. 1. In addition to these general problems, there is the great specific problem of providing a track which will have a long life. The tracks and, to a lesser

TABLE 1. Types of Automotive Vehicles Available for Combat Purposes
(In Order of Mobility)

Item	Type	Strategic mobility (on roads)	Cost	Availability in quantity	Tactical speed,[1] m.p.h.	Status of development
1	Special track-type tractor	Poor	High	Poor	20	Good
2	Commercial track-type tractor	Poor	Low	Excellent	5	Excellent
3	Convertible vehicle (wheel and track)	Good	High	Poor	20	Poor
4	Portée[2]	Good	Medium	Excellent	20	Excellent
5	Half-tracked vehicle	Fair	Medium	Poor	15	Fair
6	Multi-wheel drive (6 or more)	Excellent	Medium	Poor	20	Fair
7	6-wh. 4-wheel-drive with detachable tracks	Excellent	Medium	Poor	20	Fair
8	4-wheel drive	Excellent	Low	Poor	20	Good
9	2-wheel drive	Excellent	Low	Excellent	20	Excellent

[1]Maximum tactical speed given as 20 miles per hour as this is considered maximum practical speed across country.
[2]"Portée" refers to the use of a commercial tractor for tactical mobility, the tractor being carried in a truck when necessary for strategic mobility.

TABLE 2. Comparative Weight of Major Tank Units, Crew Space and Fire Power

VEHICLE	Total Vehicle Weight, Lbs.	Engine B. H. P.	Ratio Power Weight to Total Vehicle Weight in #	Power System Weight per H. P.	Transmission	Engine, Eng. Supports and Clutch	Final Drive	Steering Clutches	Cooling	Total Power System	Armor Plate, Wt.	Armor Pl. Wt., % of Total	H. P. per Ton, Total Wt.	REMARKS	Cu. Ft. Crew Space	Cu. Ft. per Ton Tot. Wt.	Fire Power, Lbs./min./Ton Wt.
Medium Tank T-1, 23-Ton 1926	46.000	200	14.9	34.	10091835	1600	2-Compound Epicyclic Units 1500	900	6844	15.000	32.5	8.7		248.	10.8	3.1	
Light Tank T1E1 1928	15.120	90	25.5	42.5	11301100	885	420	295	3830	4135	27.5	12.		72.	9.6	1.6	
Medium Tank T2 1930	31.000	300	22.5	23.	32001600	1060 Dr. Sproc Included	Included in Trans. Weight	1084	6944	10.500	34.	20.		203.	13.5	9.5	
Medium Tank T3 (Christie) 1931	22.300	300	17.	12.65	6001476	750-Chain 1050-Gear	370	600	3796 Chain 4096 Gear	4224	18.8	27.2		Final Drive is Separate from Transmission	98.	8.9	1.1
Combat Car T2 (Convertible) 1931	17.000	150	18.2	20.6	1200 600	Included in Transmiss.	1300 Includes Dr. Sproc	Included in Eng. Wt.	3100	3010	17.8	17.5		Final Drive Included in Trans., Diff. and Steer. Clutches	128. Design 3/26/32 77. Present Vehicle	16. 9.6	4.
Light Tank T1E4 1932	17.000	150.	22.8	26.	11301100	885	420	350	3885	5060	30.	17.6		Estimated from Component Wts. of T1E2 Tank	102.	12.	5.8
Six Ton Tank M. 1917 1917	15.000	40	15.6	58.5	230.850	1075	210.	200	2335	5000	30.	5.3			55.6	7.4	1.7
Mark VIII Tank 1920	87.000	330	19.6	32.	44001600	3366	Included in Trans. Weight	1400	10.766	29.000	33.	7.7			560.	13.	4.2

degree, the suspension of the tank are the elements having a much shorter life than the remainder of the vehicle. In fact, the tanks built during the World War had a track life of from one to two hundred miles, whereas now we can expect from two to three thousand miles, if the pins and bushings of the track are renewed once or twice during this period, depending on conditions.

It has been found that a short pitch (about 4 inches) track of drop forged steel, S. A. E. 3135, heat treated to a scleroscope hardness of about 65, is the best from the standpoint of wear, resistance to cracking and quiet operation; further, it has been found that for high speed a track shoe must be used which is practically flat externally, that is, has no integral grouser.

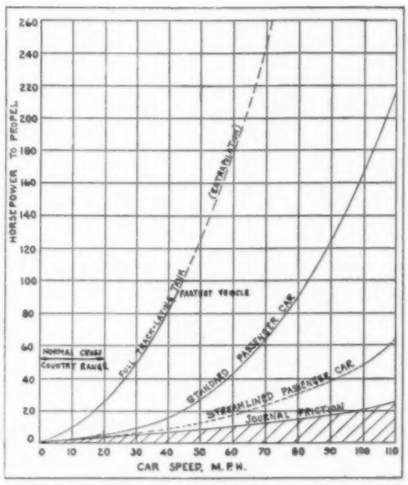


Fig. 1. Curves of Power vs. Speed of Tracklaying vs. Wheeled Vehicles.
Basis: 3800-lb. vehicle—Data from actual tests.

With respect to steering, the epicyclic and controlled differential types of steering used in some of the earlier models have given way to the much simpler steering-clutch type of steering. The latter system has the advantage of simplicity and of allowing the vehicles to pivot, but on the other hand it is not quite as safe or flexible at high speeds. In a clutch-steered vehicle, each track is driven through a separate clutch behind the main clutch; in turning, the clutch on the side to be turned to is released and a brake applied. These events, in the latest tanks, occur automatically in proper order through the operation of a conventional truck steering wheel.

Table 2 is a tabulation showing some of the major elements in tank design as exemplified by the various typical tanks developed by the Ordnance Department since the World War; this table shows the greater all-around efficiency of large vehicles as compared with the small ones; also the large proportions of the weight taken up by the armor protection and the power system. Rather than discuss the development and principles of tank design further in the abstract, it is believed better, after the above generalizations, to resort to the case method, that is, to study some of the latest typical vehicles which have been developed in this country.

THE Medium Tank, T1, is the third tank developed by the Ordnance Department since the World War and was completed in 1925. This tank weighs 23 tons and with its 200 horsepower Packard engine had a maximum speed of about 10 miles per hour. Recently this tank has been re-engined with a 330 h. p. Liberty engine to give it a maximum speed of 14 miles per hour, as a lack of power was its principal defect.

Fig. 2. The Medium Tank, T2.

Fig. 2 shows the Medium Tank, T2, completed in 1930. This tank while having the same general armor protection and fire power as the 23-ton tank, weighs only 15 tons and, in addition, has a maximum speed of 22 miles per hour. The turret mounts our newest tank gun, a 3-pdr. or 1.85-inch semiautomatic gun, and a caliber .50 air-cooled machine gun in a dual flexible mount with a telescopic sight. This type of gun mount is distinctly a development of the Ordnance Department and has been very successful; it gives the tank gunner all-around fire power both against personnel and against matériel. The guns may be moved 15 degrees right or left and up or down, independent of the turret, by the single turret gunner who controls the guns and mount from a shoulder support. The armor protection is 1-inch thick on the vertical surfaces in the most important places. In addition to the turret guns, a 37-mm. auxiliary or reserve gun is provided next to the driver; this gun can only be fired forward.

As an instance of the problems of tank designers, it is interesting to note that in this 15-ton tank exactly one-third of the weight is taken up by the armor. This tank is now undergoing service test at Fort Benning, Georgia, and reports indicate that it is a very successful machine. The Medium Tank, T2, is believed to be the most powerful fighting tank in the world in fire power, speed and armor; in addition it is very reliable.

WHILE the medium tanks have been developed to take the place of the heavy 44-ton Mark VIII Tank used during the War, and of which some are still on hand in the service, there exists also a requirement for a modern light tank about 8 tons in weight to take the place of the 6-ton Tank, M1917, which is now standard equipment in the tank units of our Army. It may be well to state at this time that the 15-ton limit on medium tanks has been set with a view to their being able to cross the heaviest mobile pontoon bridges of the Army, while the limit on light tanks has been set to enable light tanks to be transported by truck. As a matter of fact, a 10-ton tank could readily be transported in a modern truck, and we have actually recently moved both the 15-ton and the 23-ton tanks discussed above a distance of 60 miles over public highways by putting these tanks each on a large trailer behind a 6-wheeled 10-ton commercial truck, such as are now being used for prime movers for antiaircraft artillery.

The Light Tank, T1E1, was completed in 1928; it weighs 7½ tons, has a maximum speed of 20 miles per hour, is armored against ordinary machine-gun fire and carries a crew of two men. The armament in the turret consists of a 37-mm. gun and a caliber .30, air-cooled machine gun mounted in a combination mount of the type previously described. An artillery motor reel, for carrying and laying telephone wire, and other accessory vehicles, mounted on the same chassis as that of the Light Tank, T1E1, have also been built. Such vehicles illustrate a principle of considerable importance in mechanization, that is, that the tank chassis may successfully be used for a number of other purposes such as a mount for self-propelled guns, and as a chassis for wire-laying vehicles, cargo carriers, etc. The use of the same chassis for related combat vehicles has many obvious advantages in both manufacture, operation and maintenance.

Fig. 3. The Light Tank, T1E4.

While the light tank of the T1E1 type was found to be very rugged, dependable and to have a track life, between overhauls, of 1500 to 2000 miles, it was handicapped by a lack of proper strategic or road mobility. This is due chiefly to its link-type suspension which, while simple and rugged, has no springs. Although in 1928 five such tanks were taken over the concrete roads from Fort Meade, Maryland, to Gettysburg, Pennsylvania, and back, a distance of 144 miles, at an average speed of about 8 miles per hour, the wear on the machines, the noise and the vibration were such as to make moves of this kind undesirable; this applies both to the machine and to the crew. With this in mind one of these light tanks was recently modified at Rock Island Arsenal into the Light Tank, T1E4, shown in Fig. 3. This modification was accomplished by reversing the bevel gear in the transmission so that the tank runs normally in the opposite direction. This resulted in the engine being in the rear, as desired by the Infantry, while still being able to maintain the balance of the tank by having the transmission in the front and by driving the track by a front sprocket; that is, the normal relation of the power units was maintained by being installed in reverse order to that in use in general automotive practice.

A track-laying machine driven by a front sprocket is a new development never before (so far as I know) undertaken in this country, although the Vickers tank made in England has employed this method of propulsion for some time, as does the Citroën-Kégresse half-tracked tractor. Tests to date indicate the desirability of the front sprocket drive aside from the advantages it gives in proper weight distribution when the engine is placed in the rear. It will also be noted from Fig. 3 that the new arrangement makes it possible to locate the turret in the exact center of the vehicle where it is least subjected to oscillation and pitching. However, the distinctive feature of this tank is its suspension, a highly articulated system of leaf springs and bogies, the latter supporting double track rollers fitted with special solid rubber tires. This suspension, with the short pitch, drop-forged, alloy steel track used makes possible high speed travel on improved highways, with very little or no damage to the highway, and with much less damage to the vehicle and its crew than in the case of tanks having metal rollers and less flexible or rigid suspensions.

The Light Tank, T1E4, has a high degree of road or strategic mobility and can, I believe, accompany a cavalry unit on the march without the use of a tank carrier or truck. This tank has a long narrow seat on the longitudinal center covering the housing inside of which is the propeller shaft running from the engine in the stern to the transmission in the bow. The hull is practically entirely assembled by welding, a system of tank construction which has resulted in a considerable saving in weight and cost, while giving at the same time a more finished appearance and allowing the designer greater latitude in arrangement. Particular attention is invited to the flexibility of the suspension on this tank; in addition to the leaf springs, each suspension unit is pivoted in a vertical plane about the stationary axle at the center of the spring and each bogie is pivoted in a vertical plane about its pin in the end of the leaf spring.

Fig. 4. The Medium Tank, T3 (Christie).

Referring back to Table 1 in the Light Tank, T1E4, we have been looking at what may be called a special track type

of tractor. The next type mentioned in the table, (a commercial track-type tractor), may be exemplified by a Caterpillar "20" Tractor such as is now widely used by our tractor-drawn divisional field artillery, that is, the 75-mm. gun. About one half of our field artillery units are now equipped with tractors instead of horses. Such commercial tractors have a maximum speed of 4 to 5 miles per hour; this is only about one-quarter as fast as desired, but commercial tractors are used because of their great availability and low cost. As an instance of the desirability of using commercial equipment, where it can possibly be done, it is interesting to note that a commercial divisional tractor, such as the Caterpillar "20" weighs about 8000 lbs. and costs us about $2000, or 25 cents a pound; whereas tanks which must be specially manufactured, cost from $1.25 to $2.00 a pound, that is, an 8-ton light tank, when manufactured in limited (1 to 10) quantities, costs from $20,000 to $32,000.

REFERRING again to the table of automotive vehicles (Table 1) the third type of machine is a convertible vehicle. In 1920 the Ordnance Department purchased a convertible tank designed by Mr. J. W. Christie; this was the first vehicle of the convertible type dealt with by the Ordnance Department. The first Christie tank was tested and modified extensively but it was not successful. At that time the Ordnance Department purchased the rights to use the Christie patents and any subsequent improvements thereon. Fifteen vehicles using his principles were built by Mr. Christie for the War Department and tested by the Ordnance Department from time to time to 1924, but all without success. In 1928 Mr. Christie offered for test an 8½-ton tank chassis of an improved convertible type. As a result of rather extensive tests, it was decided to procure from him some medium tanks built on this type of chassis for an extended service test. Severe tactical and engineering specifications were laid down by the Ordnance Department, in coöperation with the Infantry, for the tanks to be procured. Seven such tanks were delivered to the Ordnance Department between October 1931 and March 1932; they are now undergoing extensive proving ground and service tests. Three are being tested as Convertible Medium Tanks, T3, by the Infantry at Fort Benning, Georgia, and four as Combat Cars, T1, by the Mechanized Cavalry at Fort Knox, Kentucky. This tank is shown in Fig. 4. These vehicles weigh 11¼ tons, are powered with a Liberty 12-cylinder V, water-cooled engine of 330 brake horsepower, and carry a crew of two men (a driver and a gunner).

The turret and armament are the same as in the Light Tank, T1E1, described above. The distinctive feature of this vehicle is its convertibility—it can operate either on caterpillar tracks or on wheels. When operating on tracks, these are driven by the rear sprockets in the conventional manner of track-laying vehicles, and the tank is steered by steering clutches. When operating on wheels the tracks are removed and stored on the track shelves shown on the sides of the vehicle. The vehicle is then propelled by the two rear road wheels, and is steered by the two front wheels like an automobile. This vehicle is capable of maximum speeds of 25 miles per hour on tracks and 40 miles per hour on wheels, but the tests to date indicate that 20 miles per hour and 30 miles per hour respectively are the maximum speeds for any appreciable time, while 15 miles per hour is the proper *sustained* maximum speed.

Fig. 5. The Combat Car, T2.

In 1930 it was decided that in addition to undertaking the development of the Christie tank, now known as the Convertible Medium Tank, T3, the Ordnance Department should itself initiate the development of an independent design of lighter convertible vehicle for use by the Cavalry, to be known as a "combat car." A combat car is really a heavy armored car using caterpillar tracks for better tactical mobility. Fig 5 shows this vehicle, the Combat Car, T2, as it looks with its drop-forged aluminum tracks on. This vehicle weighs 8½ tons and is powered with an 150 horsepower, 7-cylinder, Continental radial airplane engine, which is located in the rear. The engine is water-cooled and is built from an air-cooled radial engine; a similar spare engine, air-cooled, is also provided and comparative tests are now going on between the two engines to determine the practicability of using air-cooled engines in track-laying vehicles. The simplicity and lightness of an air-cooled engine are very desirable in a mechanized vehicle. This vehicle contains a number of novel features such as a radial water-cooled engine, a great use of aluminum alloy castings, drop-forged aluminum tracks and

Fig. 6. Portée Equipment.

clutch steering (when on its tracks) aided by an hydraulic booster. It has a maximum speed of 35 miles per hour on wheels and 20 miles per hour on tracks. It is now undergoing extensive tests and some modifications.

Fig. 7. The Armored Car, T4, on 20 percent Grade.

THE next type in the table of basic types is portée equipment, an example of which is shown in Fig. 6, which shows the equipment used by the 6th Field Artillery in the Experimental Mechanized Force of 1928. It consists of a Class "B" truck carrying a 75-mm. gun and limber and towing a trailer on which is carried a 5-ton Tractor, M1917. The equipment shown would be much better if both the truck and the trailer were modern and were equipped with pneumatic tires. The figure shows the equipment in condition for road transportation, or strategic mobility. For use off roads and for going into battery position, the tractor is unloaded from the trailer and is used to haul the gun (or any of the other units as may be necessary); the tractor provides tactical or cross-country mobility. Some of our Field Artillery is so equipped.

The portée system has the advantage of using comparatively cheap and commercially available equipment to transport and move field artillery under all conditions instead of manufacturing at great expense special high speed or convertible tractors. Another instance of a portée operation is the carrying of light tanks in commercial 6-wheeled 4-wheel drive trucks of 10 tons pay load capacity; these trucks are equipped with balloon tires. We should note here that such portée tank equipment achieves practically the same purpose as a convertible tank, with the following advantages:

(a) The tank, being built only as a tracked machine, has better tactical and fighting qualities.

(b) Its strategic mobility is achieved by a commercially available truck built for that purpose. The conversion from one condition to the other can be accomplished in a few minutes, whereas it takes about an hour in the case of present convertible tanks.

(c) The equipment is less expensive and less complicated.

(d) The truck or tank carrier may be used as a supply vehicle when the tank is in combat and the carrier can also carry back disabled tanks.

On the other hand there is the big disadvantage to portée tank equipment that if the tank operates away from its truck on a tactical mission, some difficulty may often occur under campaign conditions in reuniting them for a strategic movement after combat. In my opinion, due to the time necessary to change a convertible vehicle from wheels to tracks, and vice versa, it will be necessary to apply tracks and keep them on as soon as the general combat area is reached, thus making the convertible machine a full tracked machine most of the time of operation.

ANOTHER important item in the mechanization program of the Ordnance Department is the development of armored cars. These are wheeled vehicles and have so far fallen in Classes 7, 8 and 9 of Table 1. A few types of armored cars were developed by our Army during the World War; these were never put in production, as the stabilized warfare in France did not require them. The development was entirely suspended at the close of the World War. The Medium Armored Car, T2, was developed in 1928 for the then mechanized force; this was built on a La Salle passenger car chassis. The armament consisted of a caliber .30 air-cooled tank machine gun mounted on a pedestal mount having all-around antiaircraft fire. About a year after four of these cars had been in service with the mechanized force and the 1st Cavalry Division in Texas, the gun mounting was found unsatisfactory and these cars were modified, the modification consisting principally of mounting a turret thereon. There were also built in 1928 some scout cars on a Pontiac car chassis in which two caliber .30 air-cooled machine guns are carried and the only armor protection is over the radiator and the windshield in front of the driver. Such vehicles are considered to be very useful as light armored cars, reconnaissance vehicles for field artillery, and for messenger duty. Present plans indicate that all cavalry units (both mechanized and horsed) will employ a number of such cars.

Some experimental medium armored cars were built in 1930 on a 4-wheel-drive chassis and powered with a Franklin air-cooled engine. This project was carried on by coöperation between the Quartermaster Corps and the Ordnance Department. Six cars of this type are in service; they have been particularly liked because of the 4-wheel-drive feature which gives them considerable cross-country mobility. An objection to four-wheel-drive vehicles is their limited commercial availability as compared to the 6-wheeled four-wheel-drive.

Fig. 7 shows the Armored Car, T-4, developed in 1931 and now approved as a service-test type. Twelve cars of this type equipped with real armor plate are now under manufacture at Rock Island Arsenal. This car weighs about 9000 lbs., has ⅜-inch armor, carries a crew of 4, and is powered with an 8-cylinder-V, water-cooled Cunningham engine of 135 brake horsepower, giving a maximum speed of 60 miles per hour; the

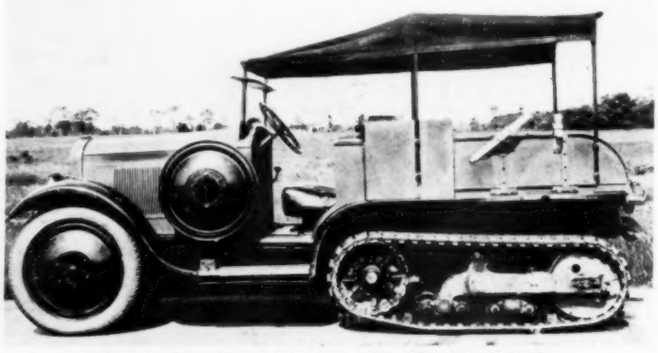


Fig. 8. The Citroën-Kégresse Half-track Vehicle.

four rear wheels are driven. The armament consists of a caliber .50 and a caliber .30 machine gun, both air-cooled, in a dual mount (the mount has a limited traverse and elevation independent of the turret) in a turret having 360 degrees traverse. This car is also equipped with radio, for both sending and receiving, by telegraph or telephone while the car is in motion. A crew of four men is carried on comfortable seats. This car has no separate chassis; the hull itself serves also as the chassis. The cruising radius is 200 miles on one filling of gasoline.

THE next type to consider is the half-track vehicle, which occurs as an item in our basic table. An early type of foreign half-tracked vehicle was tested in 1925 and at that time was found to be inadequate, due mainly to poor traction and to the short life of the rubber tracks. Fig. 8 shows the latest development of the Citroën-Kégresse vehicle. This machine is widely used in the French Army and one is under test by our Army. The half-tracked vehicle represents a practical compromise between the strategic mobility of wheeled vehicles and the tactical mobility of full track-laying vehicles. In the tractor shown the track is positively driven from the front sprocket; it has metal and rubber shoes secured to the continuous rubber belt or track to prevent slipping on soft ground. The half-tracked type of vehicle in general shows so much promise as a cheap mechanized vehicle having both tactical and strategic mobility of a high order that its further development is being actively prosecuted both here and abroad.

A light commercial 6-wheeled, 4-wheel-drive truck is now used by the Mechanized Force for carrying machine guns and their crews. This type of vehicle has cross-country mobility of quite a high order and in addition is undergoing rather rapid development commercially; furthermore it is cheap.

The 6-wheeled, 4-wheel-drive commercial truck known as the A. A. Prime Mover, M1, tows the 3-inch antiaircraft gun mount, weighing 8 tons, on roads and across favorable country. This prime mover weighs 10 tons and has a 6-cylinder, 150 horsepower engine giving it a maximum speed of about 40 miles per hour towing the 8-ton gun. As the four rear wheels are driven and are equipped with dual pneumatic balloon tires, this prime mover has considerable cross-country mobility except on soft ground. Forty new prime movers of this general type are now in service with the antiaircraft artillery (Coast Artillery Corps). A tractor is carried in each fourth battery truck to provide some tactical mobility for the guns when going into position and to extricate mired trucks. A light cheap commercial truck equipped with special wheel chains is a cheap and a fairly effective prime mover for light field artillery under all conditions except very soft or very rough terrain. A battery of field artillery so equipped is now undergoing service tests at Fort Bragg, the gun carriages being also equipped with pneumatic tires. Regardless of power and the number of driven wheels, light wheeled vehicles have much more cross-country mobility than heavy ones, and hence light cheap trucks show promise for mechanized use. Wheeled commercial tractors equipped with balloon tires also show promise, although limited in speed now to about 10 miles per hour.

IN closing this paper I wish to stress a few points which epitomize the present situation with respect to the development of mechanized equipment by the Ordnance Department. First I want to say what may appear at first unreasonable: that the development of mechanized tactics depends on there first being developed by the Ordnance Department practical mechanized vehicles and on these then being furnished to the using arm. After this first phase the necessary engineering improvement of the vehicles will follow from their use in service with troops. Let me quote, apropos of this, our own Admiral Mahan on this subject of new weapons and new tactics: "The student will observe that changes of tactics have not only taken place *after* changes in weapons, which necessarily is the case, but that the interval between such changes has been unduly long. This doubtless arises from the fact that an improvement of weapons is due to the energy of one or two men, while changes in tactics have to overcome the inertia of a conservative class; but it is a great evil. It can be remedied only by a candid recognition of each change."

Next I wish to emphasize that by far the major problems involved in the development of mechanized vehicles are the perfection of high speed track-laying tanks and other fast track-type machines. Wheeled vehicles are being rapidly developed by our large American automotive industry.

Another problem of major importance now is the selection of that engineering type of vehicle (as shown in Table 1) having the optimum combination of tactical and strategic mobility. The majority opinion at present may fairly be said to favor the convertible type, such as the Christie tank described above. However, the compromises necessary in any two-purpose machine and the length of time required for conversion from tracks to wheels, and vice versa, justify, in my opinion, a reasonable expectation that before long the full track-laying vehicle will have reached a point of practical all-around equality with the convertible chassis for tanks and all except the lightest vehicles. For the lightest vehicles I believe the half-tracked vehicle has good prospects of soon being found a more practical solution of the problem of universal mobility. The service tests now going on should in the next year or two definitely decide these questions.

LASTLY, the Ordnance Department now has to contend with the old problem of the naval designer: the question of speed versus armor. At present the British and ourselves may be said generally to favor high speed and light armor while the French favor heavy armor and low speed. If we realize that the tank was originally developed by the British to transport their attacking troops forward *more safely, not faster,* it at once becomes apparent that armor is of primary importance to a tank or other mechanized combat vehicles and that speed is secondary. Scouting or cavalry machines are analogous to cruisers and destroyers and for them speed is of more importance than armor, the ratio in each type depending on its mission.

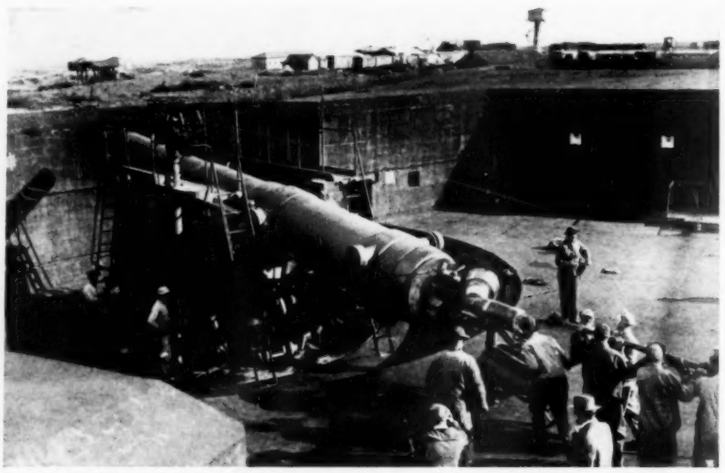
Mechanization has for its primary purpose using machines to save man power and the accomplishment of attacks which ordinary infantry and cavalry cannot accomplish; mobility is secondary so long as it is greater than that of men and/or horses. The Battle of Jutland proved that the comparatively slow and heavily armored ships of Germany could last longer in battle than the faster and more lightly armored British ships. We cannot have heavy armor and high speed at the same time and I believe that in due time heavy armor will prevail in our fighting machines. As we cannot use ball ammunition in peace it may take another war to prove this.

The Disappearing Gun Carriage

After Forty Years An Effective Element of Coast Defense

By Maj. Gen. William Crozier,* U. S. Army, Ret.

THE idea of a mounting which will effect, more or less automatically, upon firing, the disappearance of a gun behind a protecting parapet is not new. Many devices for accomplishing this object have been proposed, and a few have been put into at least experimental execution. One of the earliest and simplest was applied to the ordinary field gun, and consisted of a tapered circular segment, to be attached temporarily to each wheel of the carriage so as to convert it into an eccentric, resting on the longer axis for firing, and recoiling to the shorter one on discharge of the gun, thus lowering the piece through a short vertical distance.



The Buffington-Crozier Disappearing Carriage in Loading Position.

This device never came into general use. And the same may be said of nearly all, not only of those which reached the stage of experimental construction but of the more successful ones which got as far as a certain installation in works of fortification. The disappearing idea speedily underwent limitation to permanent works of defense, and for such works it has had some application, both for land frontiers and for sea-coast fortification.

The form most generally used for land defense has been a sunken pit, large enough to contain a gun of medium caliber, and covered with an armor plate of mushroom shape, which rested on the edge of the pit when the gun was not in use. For firing, the gun, with its covering plate, was raised sufficiently to clear the rim of the pit. After firing the system was again lowered to the protective position. But the special mechanism employed did not permit the operations of raising and lowering to be effected with sufficient rapidity to justify the disappearance of the gun between successive rounds, and it was left in the firing position during a series.

Such installations formed part of the frontier defenses of Belgium at the beginning of the World War; but they proved ineffective, for the reason that there were brought to bear on them weapons for protection against which they had not been designed. They were intended to resist the horizontal fire of guns of about the caliber of their own, some six inches; but improved means of transportation enabled the Germans to bring up howitzers of as much as 17-inches in caliber, whose vertical fire of enormous shells speedily knocked the Belgian emplacements to bits.

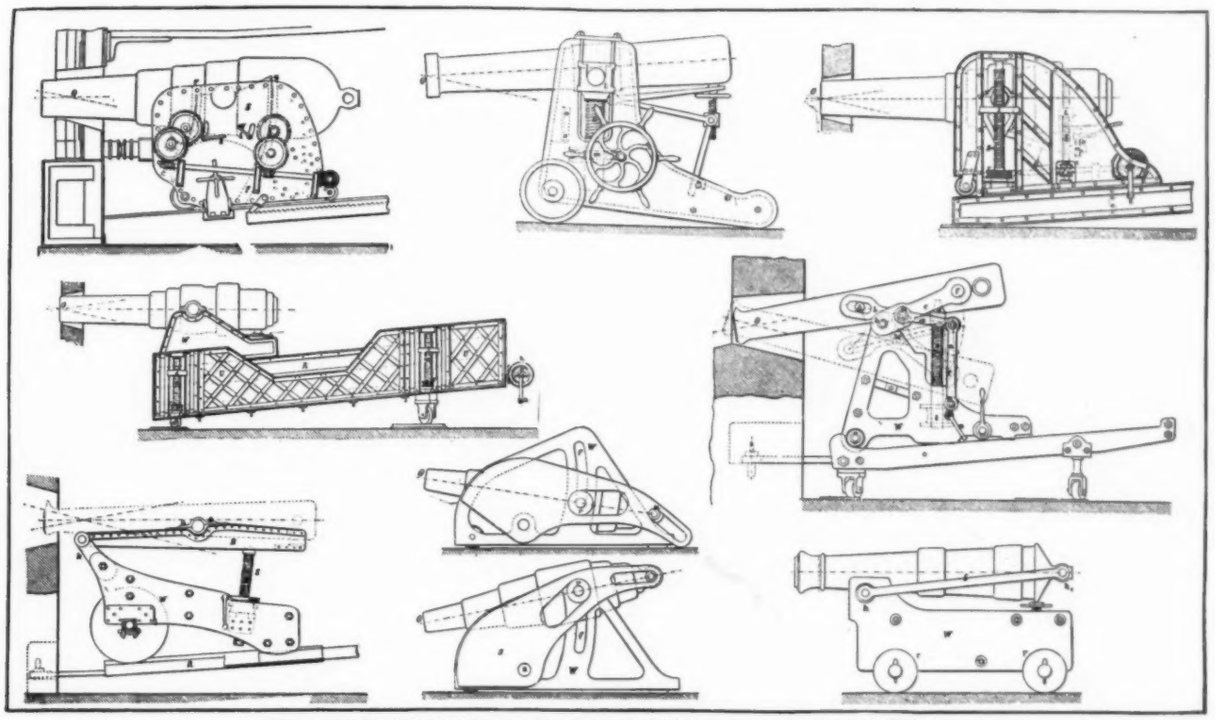
But it is for sea-coast, or harbor, defense that the disappearing principle has received its strongest advocacy and its most extensive application. For this use the earliest type to receive sufficient support to bring about its installation in practice was one proposed by Colonel Moncrieff, of the British service. In this device the gun was mounted on the upper end of a vertical rocker, and, upon firing, rolled down in recoil on the curved rear surface of the rocker, very much as did the field gun with the mounting first mentioned above. Attached at the lowest point of the rocker was a counterweight which was raised by the rocking movement and served to lift the gun again to the firing position, after loading. Although not many of these mountings were put in service there were enough to attach the name of the inventor to the general type, and all disappearing gun carriages were, for some time, spoken of in the British service as Moncrieff carriages.

THE first type to be installed in any considerable number was the Elswick hydropneumatic carriage, gotten out by the Armstrong works of Newcastle-on-Tyne. In this type the gun was mounted on the upper end of a radial arm, pivoted at the lower end, so that the gun recoiled in a circle. The recoil was checked by an inclined hydraulic cylinder, of which the piston rod was attached midway of the radial arm. The piston was driven, upon recoil, into the cylinder which rocked slightly upon a pivot, to accommodate the curved path of the point of attachment of the piston rod to the radial arm. The liquid of the hydraulic cylinder was driven by the piston through a contracted opening after the usual fashion of hydraulic brakes, into a compressed air chamber, further compressing the air therein; the subsequent expansion of which raised the gun again to the firing position. The elevation was controlled, for varying ranges, by approximately vertical arms attached to the breech of the gun.

A large majority of the guns mounted on this carriage were of 6-inch caliber; a small number of 9.2-inch. Although a good many were installed in British dependencies, and some in foreign countries, the operation was never very satisfactory—a difficulty being the admixture of the air and liquid of the hydropneumatic cylinder, upon recoil, into a kind of froth, producing irregularity of recoil. But the mounting represented the most advanced stage of the art at the time when the rehabilitation of the coast defenses of the

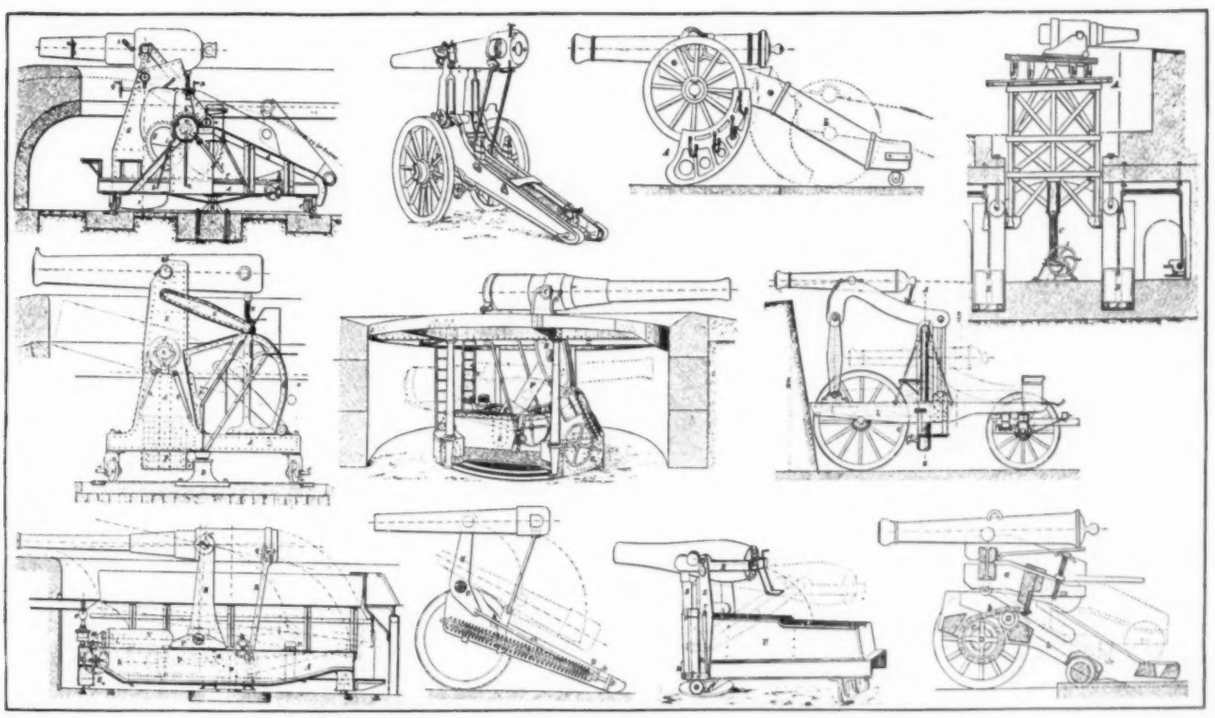
*Chief of Ordnance, U. S. Army, 1901-1918.

Early Seacoast and Disappearing Gun Carriages



Types of Metal Carriages Used in Fortifications and Aboard Ships.

Here are shown some of the unusually heavy double mounts in which the lower carriage rotates on two tracks in order that the gun may be brought parallel to the walls when rotated to one or the other extreme. The idea of providing a mechanism for permitting the gun to disappear behind the parapet is not embodied in these types but it was to evolve through these stages.

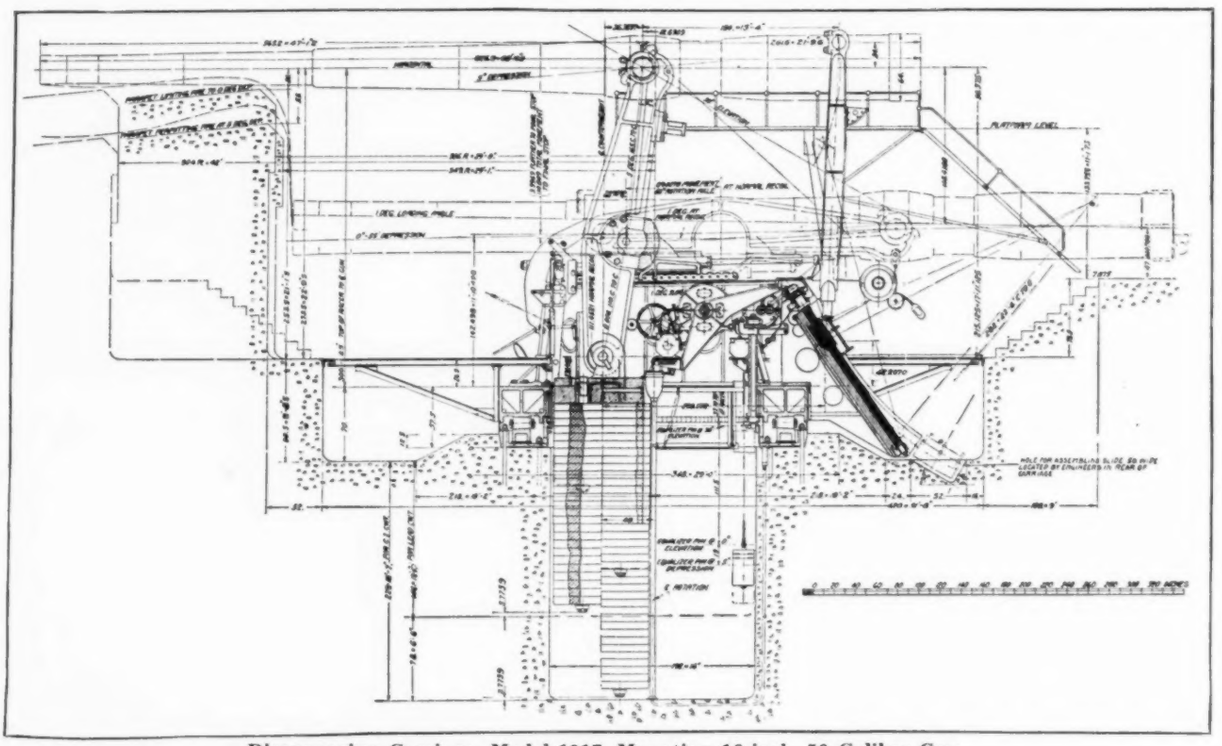


Earlier Designs in the Search for a Disappearing Weapon.

Some of these types were intended for use in the field and others were for permanent emplacement in fortifications. They represent the gradual attainment of the later perfected mount and although they seem crude now, they were apparently satisfactory for use at the time of their construction. Many, of course, did not progress beyond the experimental stage of development.

United States was commenced, pursuant to the Act of Congress of September 22, 1888.

At that time, under the guidance of the Engineer Department of the U. S. Army, it had been concluded that the secondary batteries of vessels of war had attained such efficiency as to raise grave apprehension of their ability to silence guns mounted in simple barbette, by destruction of the personnel, and the use of the disappearing type of mounting had been decided upon, if a satisfactory example could be produced. The British Government had made a series of experiments, at a place called Portland Bill, in which a dummy gun had been pulled up and down behind a parapet by a mechanical appliance, and had been fired at extensively from a vessel of war stationed at an appropriate range; with the result that guns so mounted had been deemed practically immune from harm by naval attack.



Disappearing Carriage, Model 1917, Mounting 16-inch, 50 Caliber Gun.

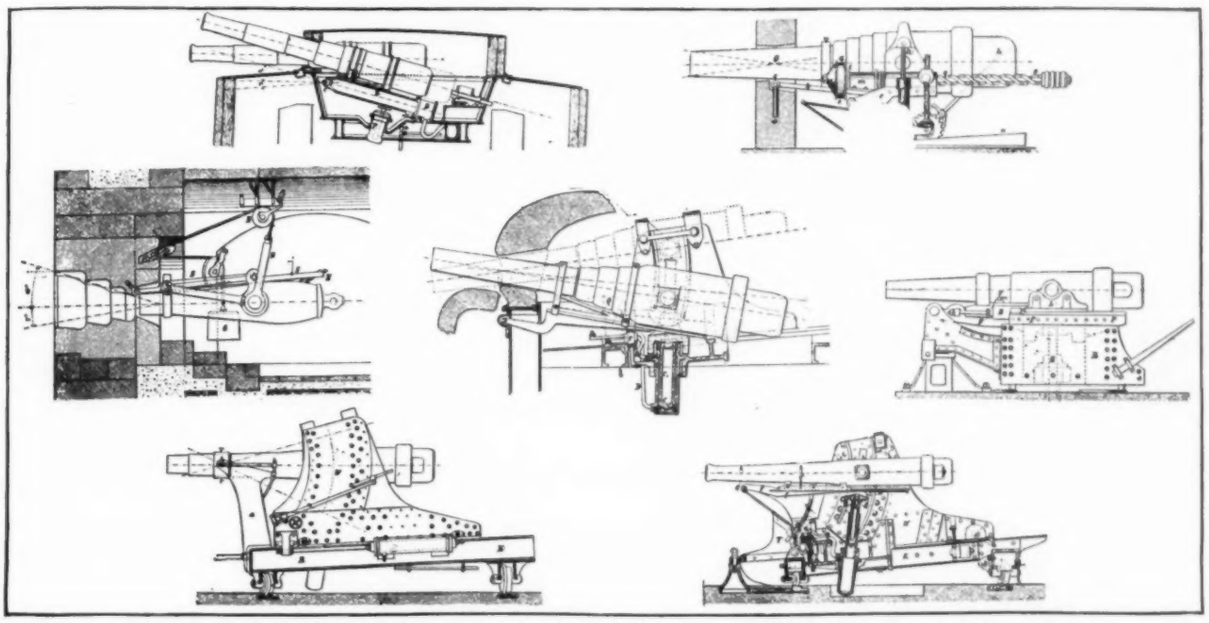
This is perhaps the limit of development in disappearing carriages. The weight shown in the well is attached to the lower end of the gun lever which supports the gun. The levers are pivoted on a top carriage which rolls on horizontal guides.

UNDER the stimulus of the demand created by these conclusions three experimental carriages for guns of 10-inch caliber were manufactured and tested. The first was presented by a private corporation, organized for the purpose, and was very similar in design to the Elswick type, described above. But the difficulty of the admixture of the air and liquid was attempted to be met by the use of compressed air alone, both for checking the recoil as well as for returning the gun to the firing position. Upon trial, the gun was fired ten rounds in something over an hour. The operation of the recoil and recuperator apparatus was very unsatisfactory, necessitating the continuous service of an air pump actuated by extraneous power. The carriage was paid for by the Government, but the type was not reproduced.

The second carriage was invented by an Army officer, but it was produced and presented by an engineering corporation, under a special allotment of funds by the Board of Ordnance and Fortification, a statutory body created by Congress for promoting the experimental development of war material. An item of the contract with the corporation provided for a penalty of one thousand dollars for each round less than ten which should be fired in an hour's time, and a bonus of two thousand dollars for each round in excess of this number, at the final test. In the system the gun was mounted on rocker arms pivoted near their middle points, and was accurately balanced by counterweights attached at the lower ends of the arms. The raising of the counterweights, upon recoil, compensated for the descent of the gun, and the energy of recoil was taken up by a cylinder of compressed air, which also provided the power for raising the gun to the firing position. At the test of the mounting an over-recoil of the piece damaged it to an extent requiring extensive reconstruction, and this consumed so much time that, in the interval, the third carriage was finished and tested.

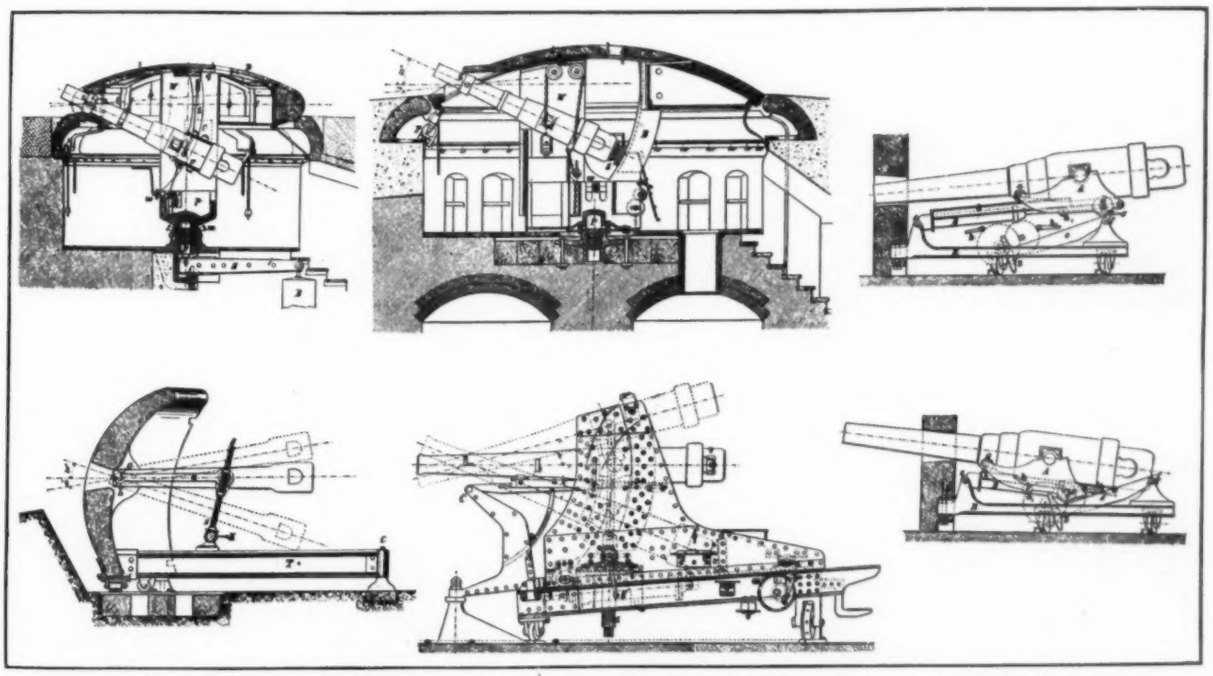
This is the one known as the Buffington-Crozier; being the joint invention of the late Col. A. R. Buffington, afterwards Chief of Ordnance of the United States Army, and then Captain William Crozier. The motion of the gun, in recoil, depends on the mathematical principle that the extremity of a straight line moving in such manner that the other extremity and an intermediate point remain, respectively, upon two other straight lines, approximately at right angles with each other, describes an ellipse. The gun is mounted, by its trunnions, at the upper end of an approximately vertical arm, the middle of which rests, through trunnions of its own, on a cradle which, upon recoil, runs to the rear on rollers resting on a horizontal surface. The lower extremity

Early Seacoast and Disappearing Gun Carriages



Forerunners of the Solution Developed for Use in American Fortifications from 1880 to 1914.

The scheme of firing through an embrasure in a wall, later to be replaced by firing above it and returning to position behind an enclosure, was not satisfactory although forts designed and built as late as the Civil War, Fort Sumter, for instance, had series of floors with cannon projecting from embrasures close together on all floors. Old fortifications of this type are familiar in America and Europe. In the above drawing is included a prototype of the cupola using armor plate over the gun.



The Advent of the Cupola Marked the Last Stage of Advance to the Disappearing vs. the Barbette Mount.

With the increasing gun elevations of today the limited scope of earlier practice is apparent. At the time of these developments when the gun was not fired from an embrasure, those embodying the disappearing principle aimed to achieve at most 15 degrees elevation and 7 degrees depression at which point any object was assumed to be safe from fire from shipboard.

of the arm slides upward, on a vertical guide, and the upper extremity, carrying the trunnions of the gun, thus moves backward and downward, in the arc of an ellipse. The breech of the gun is controlled by a radial arm, as with the Elswick mount; and the combined elliptical motion of the trunnion and circular motion of the breech gives to the muzzle a motion, first almost directly to the rear and then suddenly downward, which is particularly adapted to clear the parapet. A counterweight is attached to the lower end of the arm on which the gun is mounted, which overbalances the gun, is raised upon recoil, and, by dropping after loading, serves to raise the gun to the firing position. Incidentally it helps to absorb the energy of recoil and of the descending gun, but the major part of this energy is taken up by a hydraulic brake system, built into the cradle, with piston rods attached at the front of the mounting.

With this mounting the nature of the motion of the masses, gun, counterweight, etc., was such as to greatly soften the shock of discharge, and the resulting moderate strains were taken care of so successfully as to enable the mounting to go through the entire test without the necessity for reconstruction or repair of any part. At the final test ten rounds were fired in fourteen minutes and twenty-two seconds, thus quartering the previous record. As compared with the ordinary barbette, or overbank, mounting the rate of fire is about double; owing largely to the fact that, with the disappearing mounting, the recoil brings the breech of the gun down to a convenient height above the platform, for loading.

Subsequently the reconstructed second carriage received its final test for acceptance, under contract, when the gun was fired thirty-two rounds in an hour, (twenty-two more than the contract requirement) thus earning forty-four thousand dollars in premiums for the contractors. But the carriage was not reproduced; the tests resulting in the formal adoption of the Buffington-Crozier type.

IN planning for the construction of the new coast defenses, under the Act of 1888 and those following, it had been apprehended, in view of previous experience, that it would be impracticable to produce a disappearing carriage for a gun of over 10 inches caliber; and it was planned therefore to mount larger guns on hydraulic lifts. A typical lift battery mounting two 12-inch guns was built at Sandy Hook, to form part of the defenses of the southern entrance of New York Harbor. But the success of the Buffington-Crozier carriage for 10-inch gun was such as to demonstrate its practicability for larger calibers, and the gun-lift type of battery was abandoned.

Buffington-Crozier mountings have been built in large numbers for guns from 6-inch to 14-inch caliber, and installed in the defenses of the Atlantic, Gulf and Pacific coasts of the United States, and in those of the Panama Canal, the Philippines and Hawaii. A few have also been built for 16-inch guns. Disappearing guns form the principal feature of the American sea-coast defenses. It has been to the financial advantage of the United States that the simplicity of design and construction of the adopted type of mounting made it also the cheapest of all the forms tested. For the use of the adopted type, also, the Government was exempted from the payment of royalties. In order to avoid all question upon this point a release to the Government was embodied by the inventors in the patent specifications.

Although there has been some experimental construction of Buffington-Crozier carriages affording an elevation as high as thirty degrees for the gun, the design does not lend itself readily to a greater elevation than about fifteen degrees which does not permit the use of the maximum range of which the gun is capable. The range of the 14-inch gun, for example, at 15 degrees elevation is about 14 miles. Direct combat between ships and forts is not probable at greater ranges than this; but some of the shore guns, at least, should have as great range as any which can be fired from afloat, in order to prevent, among other things, the occupation by vessels of positions from which they might effect injurious bombardment of important areas. And modern improvement in gunnery, and in the observation of fire, is such that hits can be registered at ranges which were quite impracticable before the World War. Modern practice, therefore, tends toward the mounting of the heaviest guns on carriages permitting elevations corresponding to the maximum range of the gun: some 50 degrees, or more; and protection is provided for by emplacing them behind inequalities of the terrain or under concealment by woods or other features.

The very efficient defense of the Dardanelles, in 1915, put up by guns mounted in simple barbette, showed how far from obsolete these old style mountings were; and it indicates the probability that the American disappearing gun batteries will prove effective for many years to come, provided as they are with a type of carriage which has survived since 1890, not having been outbuilt in forty years.

The Buffington-Crozier Disappearing Carriage in the Firing Position.

Munitions Contracts in the Next War

Results of Studies to Prevent the Loss and Waste of 1918

By P. J. O'Shaughnessy*

DURING the World War all contracts for supplies for the Ordnance Department, U. S. Army, were made either at the Arsenals or in Washington. During this period a board of officers appointed by the Secretary of War attempted to draft a standard form of contract that would meet the problems of war-time procurement, but beyond the preparation of a few standard clauses nothing definite was concluded.

In the absence of a standard form of contract each agreement had to be carefully worked out by negotiators whose conclusions were submitted to the Contract Section. There a staff of attorneys carefully prepared the contract to express the nature, terms and conditions of the agreement.

From the fall of 1917 to the Armistice approximately one hundred contracts a day were made in the Ordnance Department, and upwards of 350 persons were employed in the negotiation and preparation. Usually when an agreement was reached, the contractor was given a procurement order which recited the quantity and description of the articles to be manufactured, together with the drawings and specifications, the price to be paid, the rate of delivery, and date of completion. The procurement order also contained the statement that a formal contract would follow. The preparation of formal contracts, their approval by the negotiators, and execution by the contractor consumed considerable time. (By execution I mean the signing of the contract by the contractor and contracting officer.) Often contractors took exception to some of the language in the contracts, then correspondence ensued to clear up disputed points, and it is a matter of record that sometimes contracts were not executed until several months after the date of the procurement order. In the meantime, the contractor, realizing that there was an urgent need for the supplies, proceeded with the work and relied on the good faith of the Government to adjust satisfactorily any inaccuracies between the contract as written and the agreement as made with the negotiators. Because of the delay in executing contracts, a great many contractors who had performed work for the Government had only the promise of a formal contract when the Armistice was signed. Soon after the signing of the Armistice, the Comptroller of the Treasury ruled that the need having ceased on November 11, 1918, contracts for munitions should not be executed after that date. By this ruling several thousand contractors were placed in the position of having in good faith either prepared to, or actually performed, work for the Government without having a formal contract. The effect of this will be seen later.

It was impossible for the few contracting officers who were stationed in Washington to read and digest the hundred and more contracts per day that were laid on their desks, and they delegated the duty of signing to officers whom they believed were thoroughly capable of studying the terms and seeing that the interests of the United States were properly protected.

*Formerly Chief of the Advisory Division, Office of the Chief of Ordnance. Lieutenant Colonel, U. S. Army, Rtd.

THE preamble to all Ordnance contracts made during the World War was, in substance, as follows: "These articles of Agreement entered into this (date), by and between the Richard Roe Company, a corporation organized and existing under and by virtue of the laws of the State of (incorporation), and having its general office at (place) (hereinafter called 'The Contractor'), of the first part, and the United States of America by John Doe, Colonel, Ordnance Department, United States Army (hereinafter called 'The Contracting Officer'), acting by and under the authority of the Chief of Ordnance, United States Army, and under the direction of the Secretary of War, of the second part: . . . ."

Unwittingly, the inclusion in the preamble of the name of the contracting officer of the United States proved a source of trouble for contractors which deprived many of them of profits they had earned. The trouble arose in this way: The law provides that all contracts made by the War Department, to be binding upon the Government, must be reduced to writing and signed at the end by the contracting parties. The Comptroller of the Treasury ruled that a contract to be binding upon the Government must be signed by the contracting officer whose name appears in the preamble. By this ruling all proxy-signed contracts—that is contracts which were signed by officers other than the one whose name appeared in the preamble—were declared invalid. Several thousand contractors who believed they had formal contracts with the United States were thus placed in the unfortunate position of having performed considerable work and made large expenditures for the Government without having a binding obligation.

Finance officers of the Government had made payments to these contractors, and a situation existed which demanded remedial legislation. The question was submitted to Congress and that body, in March, 1919, enacted a law, commonly referred to as the "Dent Act," which authorized the Secretary of War to adjust, pay and discharge these informal agreements, but prohibited the payment of any profits.

After the passage of this act, the War Department Board of Contract Adjustment was created. The function of this board was to hear persons, firms or corporations who believed they had contracts with the Government and to determine if contracts existed. The Board, having taken testimony, decided upon the nature, terms and conditions of the agreement, if any, between the claimant and the Government. If an adverse decision was reached, the claimant usually appealed to the Secretary of War who made final decision. When the decision was favorable, the contract as stated by the Board was referred to a District Claims Board which determined the amount due.

IN the meantime all work under contracts or orders of every kind issued by the Ordnance Department had ceased. As soon after the Armistice as conditions would permit, contractors were requested to suspend operations and submit claims arising out of contracts on which work was terminated. Most contractors were eager to cease operations

on the manufacture of munitions and resume their peace-time avocations. For the most part, all work was stopped in December, 1918, and upwards of 26,000 claims were filed with the Ordnance Department. Until the district claims board had determined the amount due the contractor, its plant was congested with Government material, thereby depriving it of the use of at least a portion of its facilities. Many contractors had borrowed from banks the money necessary to finance their operations, and they were therefore unable to use all their facilities or, sometimes, to obtain additional loans to resume their normal peace-time business. It was nearly two and one-half years after the Armistice before the claims boards completed their work. Those contractors who had borrowed from banks were compelled to pay interest on their borrowings, but they were unable to collect interest on the money due them from the United States, as the Government does not pay interest on its contract obligations.

TO add to their troubles, contractors who did not have formal contracts were now required to prove the actual amounts expended for labor, material and overhead, and these amounts were checked by government auditors and accountants. It was exceedingly difficult to determine with accuracy the cost of work in process, to fix the amortization on buildings and machinery, to determine the amount of overhead and the items that should be included therein which were applicable to the work. Disputes arose between the claimant and the claims board representatives, weeks and months were spent on investigations, and appeals to the War Department Claims Board in Washington were numerous.

This was the unfortunate position that thousands of contractors who had not executed formal contracts found themselves in when the World War was over. Many believed that they had been unfairly treated and vowed never again to take a war contract from the United States. Officers of the Government did everything possible to expedite settlement. They provided for partial payments, whenever the facts warranted, in order that the claimant might be relieved of financial embarrassment; but the great difficulty was in securing the facts. The Dent Act provided for the payment of costs without profit, and it required most patient and searching investigation to determine these costs. Many claims were made for grossly exaggerated amounts. Many contained items which were clearly non-allowable. The facts were often beclouded. One thing was clear to all who had a part in the settlement of these claims, and that was that there was need for a form of contract that would admit of proper and complete execution immediately after an agreement was reached.

When the work of the Claims Board was finished, the Secretary of War appointed a board to draft standard forms of contracts to be used in time of war or other national emergency. This board was composed of officers of the supply services of the War Department, all of whom had experience in war-time procurement or in the settlement of claims arising out of the termination of contracts after the Armistice. The Board sought to produce a form of contract which would be fair alike to the Government and the contractor, and which would eliminate the difficulties I have referred to previously. They began their long and important deliberations by drafting the fixed price contract.

THIS contract as its name implies, provides for the payment of a definite amount of money for a definite quantity of work, or a prescribed number of articles. Wherever fair terms can be secured it may be used in procuring supplies. In drafting this contract the Board followed the language of the peace-time contract for supplies now universally used by the various departments of the Government, with such changes only as are deemed necessary to adapt the form to emergency conditions. Decisions, therefore, which are made with respect to the words and phrases contained in the peace-time contract will be applicable to this form of contract, and contracting officers will have the benefit of authoritative interpretation of such language. The contract forms will be printed and when negotiations are completed, it will be necessary only to fill-in the date of the contract, the name and address of the contractor, the quantity and kind of articles to be delivered, the price, the drawings and specifications under which they are to be made, and the rate of delivery. The contract can then be signed by the contracting officer and the contractor.

If thereafter it is necessary to make changes in the work, the contracting officer may, by a written order, make such changes, and the contract price will be increased or decreased dependent upon the nature of the change.

The work or articles contracted for is, of course, subject to inspection by Government inspectors, and such inspection and tests shall be performed in such a manner as to not unduly delay performance. If, in the opinion of the contracting officer, the materials or supplies do not conform to the specifications, but can be used by the Government, payment therefor may be made at a proper reduction in price.

If the contractor is delinquent in delivery, the Government may terminate the right of the contractor to proceed with delivery of such part of which there has been delay, and it may secure such part in the open market, the contractor being liable for any excess cost occasioned the Government thereby. Payments may be made on partial deliveries accepted by the Government when the amount due on such deliveries warrants.

Disputes which arise under the contract are to be settled by the contracting officer; but if the contractor is dissatisfied with the settlement he may, within thirty days, appeal to the head of the branch concerned.

There are, of course, the usual mandatory clauses that Members of Congress shall not be admitted to any share or part of the contract, and that the contract may be annulled if the contractor has employed any person to solicit or secure the contract upon an agreement for a fee, unless such person is a bona fide agent of the contractor.

DURING the World War disputes frequently arose in plants because workmen were displeased with the rates of pay or the hours of labor, or both. To adjudicate these disputes the President created a board known as the National War Labor Board which, however, had no authority to change the terms of a contract. As a result, contractors performing work for the Government were penalized whenever the board increased the wages of the employees in the plant or whenever it reduced the hours of labor. We have incorporated in the fixed-price contract a clause providing that if a federal agency appointed for the purpose of controlling the price of labor or material approves an increase in the prices which the contractor is paying for such labor or

material, the Government will reimburse the contractor for the excess costs occasioned thereby.

When the war is brought to a close and the need for munitions contracted for no longer exists, expenditures therefor should cease as promptly as conditions will permit. To accomplish this every war contract should contain a termination clause. This clause should clearly set forth the method of settlement, and it is highly desirable that the method, while accurate, be simple so as not unduly to prolong settlement. In this contract we have provided that the Government may at any time terminate the contract by notice in writing to the contractor, and in the event of termination the contractor will be paid the contract price for the articles delivered; that percentage of the contract price represented by the percentage of completion for articles which are in process of manufacture at the time contract is terminated; the cost of any material which the contractor has on hand which he purchased for the contract; the cost of cancelling any commitments which the contractor may have made for material or supplies with subcontractors; and, if the contractor submitted with his bid a list of new facilities required for performing the work, he will be paid the unamortized cost of such facilities. The contractor will not be given any prospective profits, but if the amount paid him in settlement is not adequate to make him whole, the chief of branch may add thereto a sum sufficient to cover his costs.

Provision is made for the sale of material on hand or work in process to the contractor coincident with making settlement.

The name of the contracting officer is not included in the preamble of the contract, thus precluding the probability of the question being raised that the contract was improperly signed. Of course, it is understood that contracts cannot be signed by other than duly appointed contracting officers. This, in substance, is the fixed-price contract for use in time of war.

WE realize, however, that conditions will arise which will make necessary the incorporation in this contract of other clauses than those mentioned above. It may be necessary to provide the contractor with raw materials. The contractor may be required to give a bond for the faithful performance of the contract, etc. We have provided for contingencies of this nature by drafting what are termed "optional clauses" which, when desired, may be incorporated in the contract. These optional clauses cover the following subjects: (a) patents, (b) liquidated damages, (c) approval by chief of branch, (d) payment for partially completed work, (e) materials to be supplied by the Government, (f) liability for Government property, (g) fire insurance, and (h) bond for the faithful performance of the contract. The wording of these clauses follows the language of substitute clauses prepared by the Interdepartmental Board of Contracts and Adjustments.

It is not always possible to procure munitions at a fixed price. This is especially true of some articles procured by the Ordnance Department which are not currently manufactured or currently dealt in by industry, such as high explosives, etc. The hazards involved in producing high explosives are such that contractors without previous experience might well hesitate to undertake their manufacture at fixed unit prices. An explosion such as that which wrecked the T. A. Gillespie Plant at Morgan, N. J., in 1918, might result in the bankruptcy of a contractor who had a fixed price contract for loading complete rounds of high explosive shells.

Again, it is impossible accurately to determine in advance the cost of building and equipping large projects, such as powder plants, loading plants, and cantonments. Usually it is necessary to bring to the site of such plants large numbers of men, to weld these employees into an organization, and to train them in the work to be performed. The efficiency of such labor can not be determined until after the work is in progress. Nobody can foresee the delays and difficulties that will arise in securing materials, and if such work is undertaken on a fixed-price contract the price must include an amount to cover contingencies which can not always be foreseen. If the contractor is fortunate enough to complete the work without such contingencies arising, his profit might be abnormally high. Work of an experimental nature will have to be undertaken. It is impossible accurately to estimate the cost of performing experimental work, or the cost of developing projects which are entirely new. A nation at war is on the *qui vive* for devices to arrest the progress of its opponent and to bring the war to a speedy and successful conclusion. Nations fighting for their lives are prone to take advantage of any industrial development or invention which would be of assistance in winning the war. The industrial development that preceded the World War gave men new concepts of forces that might be employed to this end. Thus the airplane was brought to a higher degree of perfection, antiaircraft guns were produced to circumvent it. The Germans invented deadly gases; protective devices were produced to ward off these poisonous fumes. The submarine was used to play havoc with sea trade; the Y-gun was invented to destroy it. After months of hostilities the warring forces were reduced to a stalemate. A condition of trench warfare set in, and the British developed the tank which ploughed through the trenches. It may rightly be assumed that should another war arise, the world would see new devices brought into play. These, of necessity, must be procured under contract.

During the World War the Government solved these procurement problems by the use of a cost-plus form of contract. These contracts provided for paying the contractor all of the costs of performing the work and gave him a percentage of such costs as profit. The more money a contractor spent, the greater was his profit. There was no incentive to the contractor to keep costs down to a minimum, and contractors who had cost-plus contracts were able to strip the plants of contractors who had fixed price contracts of their workmen by paying higher wages.

In the Appropriation Acts which were passed in June and July of 1918, Congress expressly prohibited the use of the funds appropriated therein for payment of purchases made under cost-plus contracts. Thereafter, other types of contracts were developed, none of which, however was entirely satisfactory.

In view of the prohibition against the use of cost-plus contracts, and for the purpose of procuring articles or work which could not be procured under fixed-price contracts, it was necessary to draft a contract which would eliminate the objectionable features of the cost-plus agreement, and at the same time enable the Government to procure its munitions quickly and without loss to the contractor. This has been designated by the board the adjusted compensation contract.

THE purpose of the adjusted compensation contract is threefold: 1st. To insure the contractor against loss; 2nd. To provide an incentive to produce the munitions in the shortest possible time, and, 3d. To provide an incentive for their production at the lowest possible cost.

With respect to the first of these, the contractor will be paid currently for all expenditures incident to the performance of the work. These include the salaries of the officers and employees, or that portion of them which is applicable under the contract; the wages of the workmen; the cost of all material required; the plant overhead; the depreciation on plant and facilities used; the cost of preparing the plant for performing the work; the cost of any machinery or tools which may be required for the performance of the work; and, when the contract is completed or if it is terminated before completion, the cost of rehabilitating the plant or restoring it to its original condition. In addition to being paid his costs, he will be paid a predetermined fee. Thus the contractor is insured against loss. This saves the contractor the trouble incident to borrowing large sums of money from banks and paying high rates of interest. It enables the contractor, if the work is terminated, to receive the payment of any balance due without the necessity of filing a claim.

The second point is to provide an incentive to the contractor to produce the munitions quickly. To supply troops that may be called to the colors with munitions promptly is of paramount importance. The availability of munitions on the firing line soon after declaration of war may mean the saving of thousands of lives and shorten the war with a huge financial saving to the nation. As an incentive to produce munitions expeditiously the contract provides for the payment of a predetermined fee upon completion of the work. If, for example, the estimated time for completion of the work is one year, a fee based on the value of the contractor's plant and capital used in that period is determined and made a part of the contract. If the contractor performs the work in less than one year the full fee is paid. The contractor therefore has an incentive to complete the work in the least possible time. If, on the other hand, it takes longer than a year to complete the work, no additional fee is allowed.

The third point is to provide for the production of munitions at the lowest possible price. It is apparent that if the Government, without any limitation, paid all of the contractor's costs, there would be nothing to prevent a contractor from paying abnormally high prices for materials, or from attracting workmen from competing plants by the lure of higher wages. This was the principal objection to the cost-plus contracts used during the World War. In the adjusted compensation contract the salaries of the officers, the rates of wages to be paid for the various classes of labor and the unit prices of the material to be used on the work are set forth, and these prices may not be exceeded unless a federal agency appointed for the purpose of regulating the prices of labor and material alters it. In the absence of such agency, the chief of branch may authorize necessary changes. The contract provides that if the contractor produces the articles or work called for at less than the estimated cost, he will be given a share in the savings. This offers an incentive to the contractor to keep costs down to a minimum and to devise ways, based on ability and experience, of performing the work more economically.

THE final negotiations for work under this contract are summarized in what is termed "Exhibit A." This exhibit is made a part of the contract and is a proposal from the contractor to perform certain work in accordance with the specifications, schedules and drawings stated therein.

The contractor agrees to make deliveries and complete the work at a certain specified time.

The designations and rates of pay of the various classes of labor which will be employed in the work are set forth in this exhibit, and if during the life of the contract the contractor finds it necessary to insert additional designations and rates of pay, these may be inserted.

There is also set forth in this exhibit a bill of material required for the work, together with the current market prices. As in the case of labor, if the contractor at the time of completing the negotiations has overlooked any item of material which may be required, the bill of material may be amended.

Parts of the work which will be subcontracted for must be set forth in the exhibit, together with the name of the subcontractor and the estimated amount of the subcontract.

If it is necessary that the contractor erect additional buildings or procure additional machinery, the United States will pay the cost of such buildings and machinery, but a statement of the kind, quantity and estimated cost must be included in the exhibit.

It was necessary during the World War for the Government to supply contractors with certain material, and it is conceivable that in another national emergency the United States may again purchase and apportion to its contractors certain materials. If the United States is to furnish under this contract any materials or facilities for performing the work, these will be listed in the exhibit.

The amount to be allowed for depreciation on the machinery, buildings, and facilities owned by the contractor will be determined at the time of negotiation, as well as the cost of restoring the plant to its original condition when the work is completed. These estimates will also be included in the exhibit.

Based on the foregoing, the estimated cost for performing the work will be determined.

The fee to be paid the contractor for performing the work will also be inserted in the exhibit. This fee is based on the estimated value of that portion of the buildings, machinery and facilities owned by the contractor and used in connection with the work, and the estimated amount of capital that will have to be provided by the contractor to meet current payments prior to reimbursement by the Government.

When Exhibit A is completed, the work of preparing the contract is almost negligible. All that is necessary is to insert in the preamble to the contract the date on which it is entered into and the name and address of the contractor. The contract can then be signed by both parties to it. For reasons already stated, the contract proper omits from the preamble the name of the contracting officer.

IN the performance of the work it will be necessary for the Government to provide inspectors and auditors to inspect the material and audit the accounts. This personnel will be paid by the Government, and no part of their salaries or expenses will be included in the estimate. However, since they must have office space, and since it is probable that it

may be necessary to provide storage for the finished material, the estimated value of any buildings that may be used for offices or storehouses should be included in the estimated value of the buildings owned by the contractor and used in connection with the work. In this way there will be included in the fee a sum to cover the rental value of the buildings used.

The contract provides that the contractor shall submit summaries of accounts setting forth the expenditures for which reimbursement is sought, and the Government will reimburse the contractor for all expenses legally made which are approved by the contracting officer. Exception is made with respect to payment of certain expenses, such as federal taxes, interest on debts owed by the contractor, brokerage fees on commercial paper, etc.; but all these exceptions are listed in the contract.

The Government reserves the right to make changes in the drawings and specifications, but these must be ordered in writing by the contracting officer. It may also direct temporary suspension of the work. The cost incident to such suspension will, of course, be borne by the Government. The Government may procure additional facilities if, in the opinion of the contracting officer, such facilities are necessary. Such facilities will be paid for by, and become the property of, the United States. If, however, the Government makes changes in the drawings, or temporarily suspends performance of the contract, the contractor is required to submit to the contracting officer an estimate showing the increased cost or saving resulting from such change, and the estimated cost will be increased or decreased accordingly.

If upon completion of the work it is found that the cost of performance is less than the estimated cost, adjusted for any authorized changes, the Government will pay to the contractor, in addition to his fee, a sum determined by taking the percentage which the difference between the actual cost and the estimate bears to the estimate, dividing that percentage by 4 and multiplying it by the actual cost. Should, however, the cost of the work be greater than the estimate, the fee will be reduced one per cent for each one per cent the cost exceeds the estimate; but in no case will the fee be reduced by more than fifty per cent.

The rehabilitation costs will be paid upon completion or termination of the contract. The depreciation allowance will be paid in equal monthly installments during the life of the contract.

If the contractor is required to perform over-time work, the Government will compensate him for any additional cost occasioned thereby—such as payment of time-and-a-half or double-time. If the contractor has on hand material which he desires to use in performing the work, such material may be taken over by the Government at current market prices not in excess of those set forth in the exhibit.

Careful record must be kept of expenditures, and if the contractor's method of accounting is such that costs are readily ascertainable, no material change will be made therein. The Government is interested in determining the actual costs, and the records must be kept in such a manner as truly to reflect such costs.

The Government reserves the right to reject articles which contain defective material or workmanship. The cost of defective material or work will be reimbursed to the contractor, unless such defect is due to fault or neglect on his part—as, for instance, where a contractor in the performance of the work uses material which has been rejected by the Government.

Should the contractor fail or neglect to prosecute the work in accordance with the terms and conditions of the contract, the contracting officer may, with the approval of the chief of branch, appoint representatives to carry on the work in the plant of the contractor. The costs occasioned thereby shall be part of the costs under the contract. Or, if the contracting officer so elects, he may cancel the contract, in which event the contractor shall not receive any fee or compensation, and the Government may remove from his plant any materials, buildings or facilities for which it has paid.

WHEN work under contracts was terminated after the close of the World War, the subcontractor usually claimed and, under state laws, was legally entitled to, anticipated profits. In the adjusted compensation contract the Government prescribes a termination clause which must be incorporated in all subcontracts. This termination clause sets forth the method in which the prime contractor will make settlement with the subcontractor. Briefly, the plan is to pay the subcontractor the contract price for articles or work completed, and for any material which the subcontractor has on hand for the performance of the work. For articles in process of completion the subcontractor will be paid that percentage of the contract price represented by the percentage of completion. If the amount thus determined is not adequate to make the subcontractor whole, the prime contractor may add thereto a sum sufficient to cover the subcontractor's costs. All payments to the subcontractor must be approved by the contracting officer.

The contract may be terminated by the Government at any time upon notice in writing from the contracting officer. In such event the Government will pay the expenditures of the contractor made for the protection, collection and disposition of government property, and for accounting services incident to the completion and determination of payments and settlements under the contract after date of termination. It will also reimburse the contractor for all expenditures made for performing the work, and for the cost of cancelling subcontracts. It will pay the rehabilitation costs, but the allowance for depreciation will cease as of the date when termination becomes effective. The contractor will be paid that portion of the fee which the actual time of performance bears to the estimated time of performance.

All buildings, machinery, materials, etc., for which the contractor has been reimbursed are the property of the United States, and the Government has the right to remove such property even though the buildings and machinery may be installed upon land not belonging to the United States. All scrap resulting from materials is the property of the Government.

If the contractor has furnished a bond for the performance of the contract, and any of the sureties becomes unacceptable, the Government may require the contractor to furnish additional security.

Any doubts or disputes which may arise during the life of the contract shall be referred to the contracting officer for determination, and if his decision is not satisfactory, the contractor has the right of appeal to the chief of branch.

Work designated as confidential shall be performed only by employees of the contractor approved by the contracting

officer, and no information pertaining to such confidential work shall be given to any person other than approved employees. This, in brief, is the adjusted compensation contract.

THE advantages of this type of contract to the Government and to the contractor are readily apparent by comparing results under an adjusted compensation contract with those obtained under a fixed-price contract in a hypothetical case. A contractor submits a price of $1,030,000 for doing certain work. On a fixed price contract this is a bid and the sum mentioned is payable regardless of actual cost; on the adjusted compensation contract this sum is merely an estimate. It is assumed that the estimate consists of an estimated manufacturing cost of $1,000,000 and a fee of $30,000 (6 per cent on a capital investment of $500,000 for one year).

(a) If the actual cost is $800,000, the results will be:

Fixed-Price Contract:		**Adjusted Compensation Contract:**	
Bid	$1,030,000	Estimated cost	$1,000,000
Cost	800,000	Actual cost	800,000
Profit	$ 230,000	Saving	$ 200,000
The percentage of profit on cost is 28.7 per cent.		Saving on estimate is 20 per cent. ¼ saving on estimate is 5 per cent. $800,000 X.05 = $40,000.	
		The contractor receives:	
		Cost	$800,000
		Fee	30,000
		Additional compensation	40,000
		Total	$870,000
		Profit equivalent is $70,000. The percentage of profit on cost is 8.7 per cent.	

The Government saves $160,000 by using the adjusted compensation contract in place of the fixed-price contract.

(b) If the actual cost is $500,000:

Fixed-Price Contract:		**Adjusted Compensation Contract:**	
Bid	$1,030,000	Estimated cost	$1,000,000
Cost	500,000	Actual cost	500,000
Profit	$ 530,000	Saving	$ 500,000
The percentage of profit on cost is 106 per cent.		Saving on estimate is 50 per cent. ¼ saving on estimate is 12½ per cent. $500,000 X .125 = $62,500.	
		The contractor receives:	
		Cost	$500,000
		Fee	30,000
		Additional compensation	62,500
		Total	$592,500
		Profit equivalent is $92,500. The percentage of profit on cost is 18.5 per cent.	

The Government saves $437,500 by using the adjusted compensation contract in place of the fixed-price contract. It will be noted that in a case where the negotiated estimate is twice as high as the actual cost, the Government under the adjusted compensation contract is only required to pay to the contractor a profit including fee of 18.5 per cent of his actual cost.

(c) If the actual cost is $1,500,000:

Fixed-Price Contract:		**Adjusted Compensation Contract:**	
Cost	$1,500,000	Actual cost	$1,500,000
Bid	1,030,000	Estimated cost	1,000,000
Loss	$ 470,000	Deficit	$ 500,000
Percentage loss on cost is 31.3 per cent.		Cost exceeds estimate by 50 per cent. 50 per cent of the fee ($30,000) = $15,000.	
		The contractor receives:	
		Actual cost	$1,500,000
		Reduced fee	15,000
		Total	$1,515,000
		Profit equivalent is $15,000. Percentage of profit on cost is 1 per cent.	

The foregoing examples illustrate how the adjusted compensation contract protects the contractor against loss and insures a reasonable price to the Government. In effect, under this form of contract the Government is taking over the use of the contractor's plant during the emergency, paying an agreed rental therefor, permitting him to operate it for the Government, protecting him against loss while so doing, and permitting him to share in any saving which he can effect, thus encouraging economical operation of the plant. This type of contract gives to the Government all the desirable results of commandeering a plant without the objectionable features of such practice.

The preliminary data sheet is the form on which prospective contractors will submit tentative estimates covering the cost of doing work under the adjusted compensation contract. It is hoped that plans for industrial preparedness will reach such a point that preliminary data sheets may be filled-in, during peace time, by all prospective contractors. No obligation is incurred by filling-in of this data sheet, but the detailed analysis of costs contained therein will be of inestimable value to the War Department in facilitating the negotiation of contracts if and when war is declared. The detailed estimates can be subjected to careful scrutiny in peace time, and the preliminary data sheets can be revised from time to time as investigations determine inaccuracies or miscalculations therein.

IN addition to the foregoing, a contract form has been prepared and designated "Fixed Price Contract (Construction)." This contract follows the lines laid down in the construction contract to be used in time of peace prepared by the Interdepartmental Board on Contracts and Adjustments.

The principal deviation from the peace-time form is that with respect to changes in the prices of labor and material. As in the fixed-price contract (supply), provision is made that if a federal agency appointed for the purpose of fixing prices of labor or material increases the price which the contractor is paying, the Government will reimburse him for such increase.

The contract also contains a termination clause, which provides for the payment of all expenditures of the contractor made in accordance with the terms of the contract, less amounts previously paid, as well as the costs which the contractor has been subjected to by reason of termination, such as collecting and storing government property, and terminating subcontracts. In this contract the Government agrees to pay the contractor, as profit, a percentage of the total expenditures made for work performed. The reason for this is that in a construction contract the price to be paid the contractor will usually be for a complete building, and if the work is terminated prior to completion the contractor would be deprived of any profit unless provision is made for the payment of work performed and material used on the structure.

Observations made in this discussion with reference to other clauses in the fixed-price contract (supply), such as changes in the work, inspection, additional security, etc., also to optional clauses to be inserted in the contract when need arises, apply with equal force to the fixed-price contract (construction). Attempt has also been made to draft an "Adjusted Compensation Contract (Construction)," but the question of using this type of contract for construction work is being held in abeyance pending further consideration.

Navies and the Airplane

Part VIII: Conclusion of the Series, "Possibilities of the Tank"

By Fred. H. Wagner*

LET us imagine a convoy of merchant vessels, with their escort, at sea. Suddenly a squadron of seaplanes appears in the sky. The antiaircraft guns on the escort may bring down one, perhaps two, in the time allowable, but what will happen to the merchant vessels in the meantime with bombs dropping upon or all around them? Bombing is unnecessary if the planes are equipped to spread poison gas, in which case the result is a possible "fini" for the entire fleet, provided the escort has no source of protection other than guns. Hits from such guns will be quite difficult to accomplish, especially if there is a sea running. The escort will be moving and it will be visible to the airmen, quite a different case from one on land, or where the gun is on a stationary platform and may be hidden from sight. In addition, the plane will be moving at an immense speed, it will be diving and then zooming back up in the sky again, and thus it will become a target which the most expert gunner will have difficulty in hitting. It is obvious that the only possible defense in such case is by a fleet of planes, which would require the convoy to be escorted by a seaplane-carrier. Unless defense is provided through the air itself, there will be some rude surprises in store for us should we ever enter upon another war, and the bigger the convoy the greater will be the surprise.

The British Grand Fleet at Jutland was accompanied by one seaplane-carrier, and the planes released from her deck were of exceptional service for reconnaissance. But another, the converted CAMPANIA, was forgotten when the fleet received orders to go to sea, after information had been received that the Germans were out. The CAMPANIA carried her complement of seaplanes as well as a kite balloon, but she was forgotten and left at anchor. When it was learned she was al[illegible]t it was too late to make use of her, and the eventual e[illegible]e of the German fleet has been attributed to a lack of sufficient air reconnaissance. This in spite of the service rendered by the one carrier with the fleet.

OUR efforts at attack from the air have all been confined to bombing, and while the results obtained by means of bombs during the 1921 demonstration against stationary targets were all that might have been expected, it is highly questionable if they can be repeated against a moving fleet protected by a suitable air force. In contradistinction to our bombs, England places her faith in torpedoes. Personally, I am obliged to confess I feel the latter are superior in ultimate destructiveness, because they can be better directed against the object of attack than can bombs. The torpedo-carrying airplane made its first appearance shortly before the outbreak of the World War, and it was effectively employed in the Sea of Marmora against Turkish merchant ships and troop transports during the Dardennelles operations. The aerial torpedo is, to all intents and purposes, the same weapon as that fired from submarines and destroyers; it is carried beneath the plane's body and is discharged when the plane has swooped down to within a few feet of the surface of the water, the driving mechanism being started with the release of the torpedo, and the latter is driven forward under water to its target. It is obvious that direct hits are more a possibility than the dropping of bombs from high in the air.

Commander Kenworthy cites an incident in which Admiral Sueter, seven months prior to the Battle of Jutland, "begged permission of the Board of Admiralty to construct two hundred invisible-wing torpedo-carrying airplanes. This was before the separate Air Ministry had been established. He was refused, and on persisting he was exiled, or *stellenbosched,* to the Adriatic." Had the Admiralty only been air-minded, what an excellent opportunity for this weapon the Battle of Jutland would have presented! The adoption of innovations is, however, difficult of accomplishment in England as well as here and in other countries. Only too frequently we fall into the error that a future war will be fought on the same lines as was a previous one. This is all wrong, because the advances being made in science and mechanics will certainly point out new implements and new methods for wholesale destruction when the opportunity for using them arrives.

Months after the Battle of Jutland orders were issued for the construction of some hundreds of this new weapon, but they were not completed in time to be of any service, and after the Armistice they were *ruthlessly scrapped.*

COMMANDER KENWORTHY also cites one of the experimental attacks with actual torpedoes, but equipped with dummy heads, fired from airplanes in post-war maneuvers against the battle-fleet of the Royal Navy, as related by Admiral Mark Kerr:

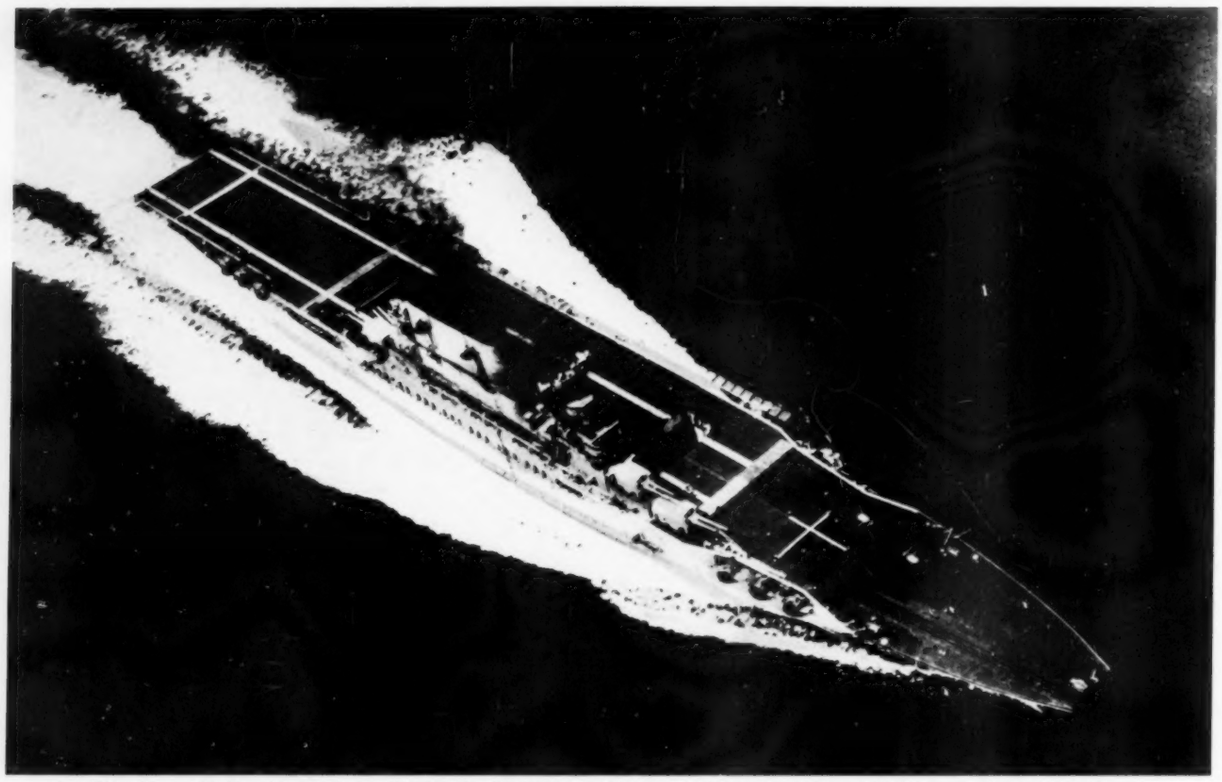
"The battle-fleet was sent to sea with orders that if a smoke screen was dropped from the air the formation of the fleet was to be broken-up in order to reduce the target offered to torpedoes. Air scouts found the fleet and wirelessed their position. High-flying airplanes came out and dropped a smoke screen on either side of the battle-fleet, which promptly broke up its formation. A few seconds later low-flying torpedo aircraft arrived, and, taking their bearings by the mastheads of their targets seen over the smoke screen, and without passing through the latter, fired blind. Forty-one per cent hits were registered without the battle-ships ever having seen their attackers. Some time later aircraft of the Royal Air Force attacked a British squadron in a fog in the Channel, and scored seven hits out of eight shots."

Could this performance have been repeated with bombs if the smoke screen had been high enough to hide the masts? I doubt it. Even though the torpedo-planes had not been able to see the mastheads, they could, in my opinion, because of their close approach to the surface and consequently of a more direct aim for the torpedo, have created more havoc in the fleet than would have been possible with bombs.

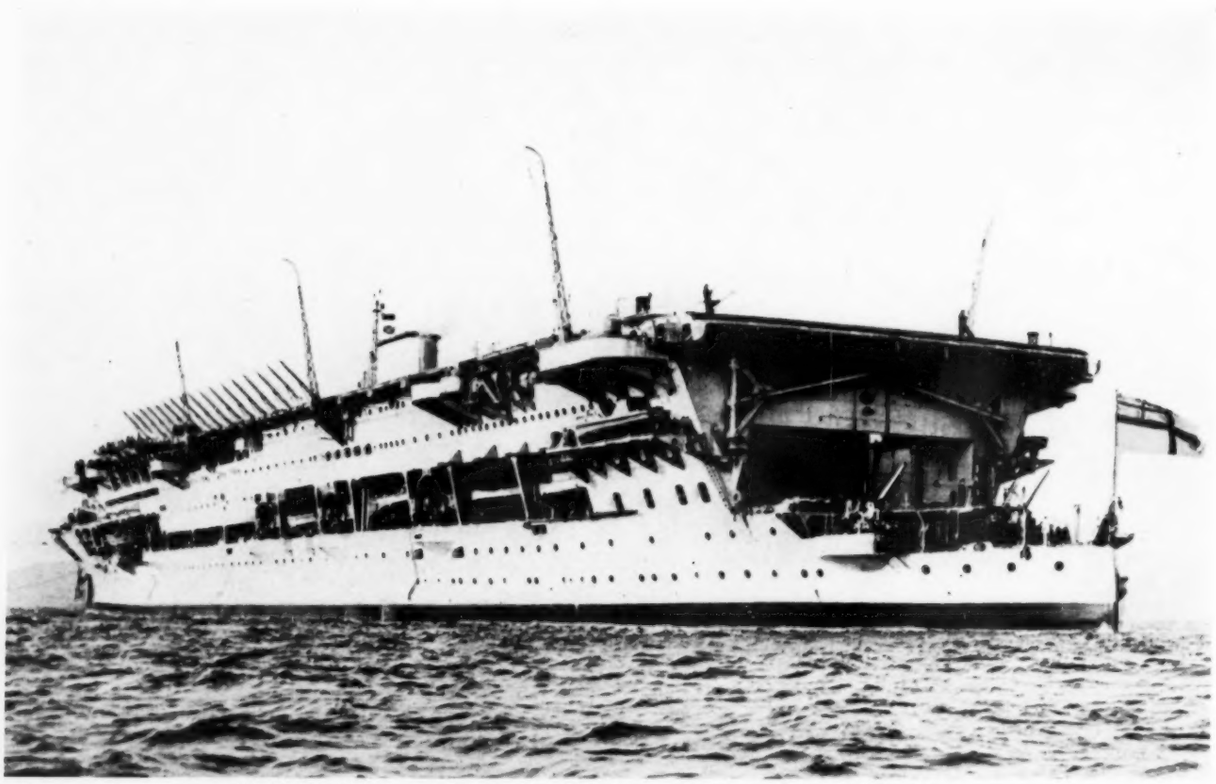
It is reported that the latest torpedo-carrying seaplanes have a very high speed. In attack they swoop down like swallows in almost a nose dive to the surface of the water

*Consulting Engineer. The Bartlett Hayward Company, Baltimore, Md. Colonel, Ordnance Reserve, U. S. Army.

Aircraft Carriers of the United States and British Navies



The Aircraft Carrier U. S. S. "Lexington" Under Full Power in Recent Navy Maneuvers in the Pacific.



H. M. S. "Courageous", Modern Floating Airdrome of the British Navy.

at a speed of between 200 and 300 miles an hour. The torpedo is directed at and dropped close to the target, hence there is no time for the battle-ship to dodge out of the torpedo's path, and a moment later the plane is again gracefully sweeping upwards into the sky.

When the Panama Canal was built attack from the air was hardly contemplated, but here is the place beyond all others where the torpedo fired from an airplane at the Canal's gates and locks can produce almost irreparable damage. Destruction of the Canal will definitely separate our battle-fleet into two parts, or isolate it altogether on one side or the other, hence the Canal Zone should be well protected by both ground defenses and a superior air force.

ONE of the deadliest dangers at sea, as stated before, is poison gas, especially for merchant ships in convoy, since they may not be at all prepared to meet such a menace, and a squadron of seaplanes can place such an *invisible* poison gas over quite an area through which, being invisible, the ships must helplessly pass. Under such a condition it is highly questionable if any human being would be left alive to tell the tale. Of these poisons phosgene and mustard gases are perhaps best known to the average reader, but they are some of the worst with which we would have to contend. As stated in a previous article, provisions may be made on land to mitigate this menace to a great extent. This is rather a difficult thing to do at sea. Hydrocyanic acid also is a poison for which there would seem to be no remedy. Chloro-vinyldichloro-arsine is a new gas which has been romantically christened the "dew of death" and which is so deadly that if it should unfortunately wet a man's skin for an area equal to only that of a 25-cent piece, death would follow in a few hours.

Other gases are being developed which will be fatal to metals on account of their corrosive qualities and which, if in contact for a few hours with gun parts or other appliances of metal would make them useless. Again, there are other gases which are intended solely for sky-raiders, or gases which have but little effect on the respiratory organs on the ground, but as one ascends in the air breathing becomes more difficult and at an elevation of between five-and six-thousand feet the lungs refuse to function, thus causing a hemorrhage which will bring down the most intrepid sky-raider.

The future may also see submarines sending gas up to the surface of the sea and which, if the wind were just right, would destroy the personnel of an unsuspecting fleet which might sail into its environs; and ships fleeing from the enemy need only to head into the wind when the gases which could be released from their sterns would soon put a stop to pursuit. Again, these same ships could drop chemicals into the sea which, after combination with the salt water, would liberate sufficient gas to make the sea untenable for many miles.

However, it must be remembered that in case of a future war its declaration will probably be followed by an immediate attack from the air should the danger confront us on either of our borders, a contingency which is highly improbable. If the war should be with an overseas nation some little time will be allowed us for preparation, especially since wars are usually preceded by a period of "strained relations" of which we could take advantage in preparedness, unless we will always remain asleep. Of such an aerial war, especially as regards the land, a former Air Minister of Great Britain, Sir Samuel Hoare, says, "In any war of the future, it will not be only a limited number of combatants who will be engaged, but it will be the whole body of the population. I shudder to think of the devastation that will be created by the development of the air arm upon our civil population. . . ." It is a sad commentary on our present-day civilization that this can be true, but there is no doubt that there is nothing so brutal and cruel as the barbarous devices developed by man to exterminate his fellows. It is thus permitted for nations to employ the most revolting and inhuman methods for settling disputes arising between them, or methods which no individual in these same nations is permitted to employ to settle his individual quarrels with his neighbors, for when he attempts to employ firearms or poison for this purpose he is promptly executed, or perhaps imprisoned for life. This latter is the standard of humanity which the law imposes upon the individual, but nations possess no such standards. Hence the disarmament conferences, peace pacts, and the League of Nations all have a monumental task before them if such conditions are not to exist in the future.

The defense against air raids on land was taken up in my previous article, but the ground defense described will not be able entirely to prevent the horrors of bombs and gas at all points, hence a superior air force will eventually be necessary to ward off the raiders, if the Navy is incapable of keeping them away from our shores. Counter-attack is therefore the ultimate answer.

WE have considered the submarine in our general discussion of the Navy's menace, and also the airplane, but in addition to these we are now also confronted by a combination of these two, or the airplane-carrying submarine. Our Navy, as well as that of France, is in possession of submarines which carry planes "knocked down" within them, but England is the first nation to experiment with a submersible which can send an assembled plane into the air within a few moments after the boat's deck has broken through the surface of the sea.

During the World War England built four submarines each equipped with a 12-inch gun with the expectation that these heavily armed submersibles would be able to approach the German High Sea Fleet in the North Sea and sink the ships with a few well-placed shots from guns with muzzles just showing above the surface of the sea. It was also expected that these boats could take station off shore and effectively bombard enemy fortifications. All these fond expectations were never realized. The great weight of the big guns and their turrets made these vessels very unstable and difficult to handle, besides which, they were of very slow speed. Of the four vessels, one was lost at sea, two were scrapped, and the fourth, known as the M-2,* was relegated to a back basin in a dock yard.

This "freak" was seemingly forgotten. But a few months ago a periscope was observed projecting above the water off Gosport, England; soon a conning tower made its appearance and, after the narrow deck of a submarine had leveled itself on the surface of the sea, men were observed emerging

*Since writing this article the M-2 went to the bottom with 61 officers and crew on January 26, 1932, off Portland Bill on the English Channel. It is presumed her hangar door opened through some unexpected cause and her entire personnel drowned through the onrush of water.

from the conning-tower hatch; they ran forward and threw open a door on a cylindrical housing just forward of the conning tower; waves were breaking over the deck, but this did not interfere with the rolling out of a plane with its wings folded back against the fuselage. These wings were swiftly extended to the normal position; they were locked in place, and the plane was rolled to a catapult erected on the deck about midway between the conning tower and the vessel's nose. A pilot and an observer left the conning tower and climbed into the plane's cockpit; the propeller began to whir; the pilot signaled with his hand; the plane was snapped forward and upward, and it left the deck with a speed of 50 miles an hour. The plane remained in the air for an hour; it was then brought down to the surface near her "mother," she taxied close to the sleek hull of the latter, and the crew of the submarine swung out a light steel boom affixed to a turntable atop of the plane's compact water-tight hangar. A hook on the end of the boom's steel cable was attached to a ring on the plane, the latter was hoisted clear of the water and landed on the deck's runway. The wings were folded into their "home" position, the plane was rolled into her hangar and the door was closed and securely fastened. The crew scrambled back into the ship, the conning-tower hatch was closed, and the M-2 disappeared beneath the waves.

BY replacing the gun and the turret with a speedy observation plane and its hangar, England is in possession of a submarine which carries a plane all set-up and ready to go into action. Tests with this vessel were carried out with considerable secrecy, but the Admiralty is not at present in a position to say that the M-2 in her new form is much more useful than when she carried a gun much too large and heavy for a boat of her size. It is known that this reconstructed submarine performs well both on the surface and when running submerged and, unless the sea is too rough, a plane assembled ready for flight can be launched from her deck.

The plane carried in the M-2 is one of the smallest seaplanes ever built, since it had to be designed to fit into its rather limited hangar. Due to its small size and its economy of wing spread, the plane can carry neither bombs nor torpedoes, its only use being for observation. The Admiralty is in hope that boats such as the M-2 will be able to approach close to an enemy fleet, rise to the surface, launch its plane and then submerge again, while the plane spots the exact location of the hostile fleet from high in the air and then promptly returns to the submarine, from which the information obtained will be radioed to the fighting fleet. It is too soon to discuss the possibilities of such boats, but exhaustive tests are under way to learn whether they and their equipment are practical.

The chief objection which has existed against plane-carrying undersea boats is the difficulty of assembling and launching a plane in a heavy sea with waves washing over the boat's low deck, but there seems to be quite an advantage in having the plane all set-up and ready for action as against the necessity for assembling it on the wave-swept deck. In spite of England's unsuccessful experience with the M-2 and her war-time sister ships, the new French plane-carrying submarines are to be equipped with two 8-inch guns and two "knocked-down" planes. The French, however, do not seem to bother much about top-heaviness, as witness their usual construction of fighting ships which rear higher above the surface of the sea than do those of any other nation, and consequently also offer a better target to the enemy's guns.

I DESIRE at this point to give one more moment's attention to the air-ship. We are at present in possession of two of these air monsters, the Los Angeles and the Akron, the latter larger than the first, and we are now building a third, the largest of the three, at a cost of more than two million dollars. For military purposes these vast gas bags, dependent as they are on expensive mooring masts and more expensive, huge hangars, with their vast size, cost and *vulnerability,* are in my opinion, and it seems also in that of all foreign Powers, quite a useless extravagance. This was all proven, without the shadow of a doubt, during the Great War and as explained in a previous article. Each of these monsters requires a ground crew of between 400 and 500 men every time one leaves or enters a hangar, and, if caught in a gale while distant from one of the few scattered mooring masts available, they are practically helpless, as witness the fate of the Shenandoah. We often read "Owing to unfavorable weather conditions, the Akron (or the Los Angeles) has abandoned her contemplated flight to—." Will we wait for favorable weather conditions to fight a war?

On January 17, the Akron tore loose from the mooring mast on the U. S. S. Patoka, near Cape Charles, only three minutes after she had been made fast; the big gas bag suffered no damage, but there being no other mooring mast available, she headed for her home port at Lakehurst, thus abandoning the maneuvers in which she was engaged. This is something more to think about. Again, on February 22, the Akron was seriously damaged by an accident which prevented flights for some weeks. A sudden increase in wind velocity came as the mammoth ship was being walked out of her hangar. She was jerked out of the control of her ground crew and her after-part was slammed violently against the ground, resulting in damage to her lower stabilizing fin and the control room located in the latter. Both were smashed, and a large section of the undercovering was ripped. It was also feared that her internal structure had been severely strained and would require a thorough inspection, and perhaps correction.

In comparison, an airplane can descend and land in an emergency on almost any large field without the assistance of any 500 men, and it is highly probable that the helicopter will be so developed in the next few years that the present objection—lack of speed—will be overcome. Yet we persist in building such useless monsters when the cost of one will provide the Navy with twenty or more superior fighting seaplanes. Why such persistence in the face of abandonment by all other Powers is beyond my comprehension. England recently scrapped her last and most modern airship!

We learn, I presume from interested parties, that while France looks with suspicion on Germany's commercial airship development, in view of its war-time value (?), some of our naval officers "sing a different song in praise of the *commercial* possibilities of the new Akron . . . more than one hundred feet longer than the Graf Zeppelin, with a gas volume 2,800,000 cubic feet greater, and a gross lift of 403,000 pounds, or 145,000 pounds more than the German craft." If the Akron was built to demonstrate commercial possibilities why not be frank in saying so? Then the limited funds available to the Navy for aircraft should not have been

wasted on her. We learn, however, that she has a flight range of 10,580 miles, and that "her most distinctive features should prove her most valuable in *commercial* operation." This refers to the hangar built in the bottom of the AKRON, and in which five *fighting* planes will be carried ready for launching at a moment's notice. It is assumed, I take it, that the airplane auxiliary will be almost indispensible when *commercial* airship lines actually begin operation. This is to prevent costly stoppages and moorings, because passengers will be brought up by plane from fields on the ground, the plane will engage the trapeze of the airship and will be drawn up into place and the passengers discharged.

I do not know whether this is all propaganda intended to confuse the civilian mind in trying to find a reason as to why Navy appropriations were spent in developing *commercial* airships or not, but in view of what happened to the Zeppelins during the Great War, and this in the face of even the primitive conditions of air fighting or defense prevailing at that time, I would pin my faith for any success in the air on the twenty or more seaplanes which the cost of one AKRON would provide.

BUT we never learn. Quoting Bernhardi: "By the lessons which we learn from military history and our own experiences we must try to discern the permanent factors with which we have to reckon, as well as the laws of development. This is the only means we have for further guidance of what in war is altogether possible and feasible. . . . But we must next closely examine under what external and internal conditions a future war will be affected by the changes in military matters since we gained our last experience in war; or what effects these changes will produce. We must examine how far the results of our up-to-date war experiences will be influenced by these new phenomena, and we must try to find out in what directions this kind of influence is likely to assert itself. In this way alone can we succeed in ascertaining the conditions that will probably obtain in the next war, and in gaining some guiding rules for our action. . . . It is not enough for us to discern the nature of modern war, and thus to some extent satisfy a *theoretical want;* we rather wish to be able to develop from this knowledge a doctrine for acting in the field—a law, as it were, of future victory."

We had no experiences with these huge airships during the recent war, but we might learn of their fate in the pages of history instead of a desire to *satisfy a theoretical want.*

Bearing the above quotation in mind, it would appear that one other lesson taught by the recent war is to the effect that even with air forces as maintained at present, it remains highly questionable whether any hostile battle-fleet will dare approach a defended coast in time of war. The attacker must bear in mind that he is always subject to an air attack at any distance up to say 500 miles from the coast, and the menace offered by this attack is exceedingly greater than that of either torpedo or mine, which latter prevented the British fleet entering the Bight of Helgoland during the Great War, and also deterred the German fleet from attacking the vital communications across the English Channel.

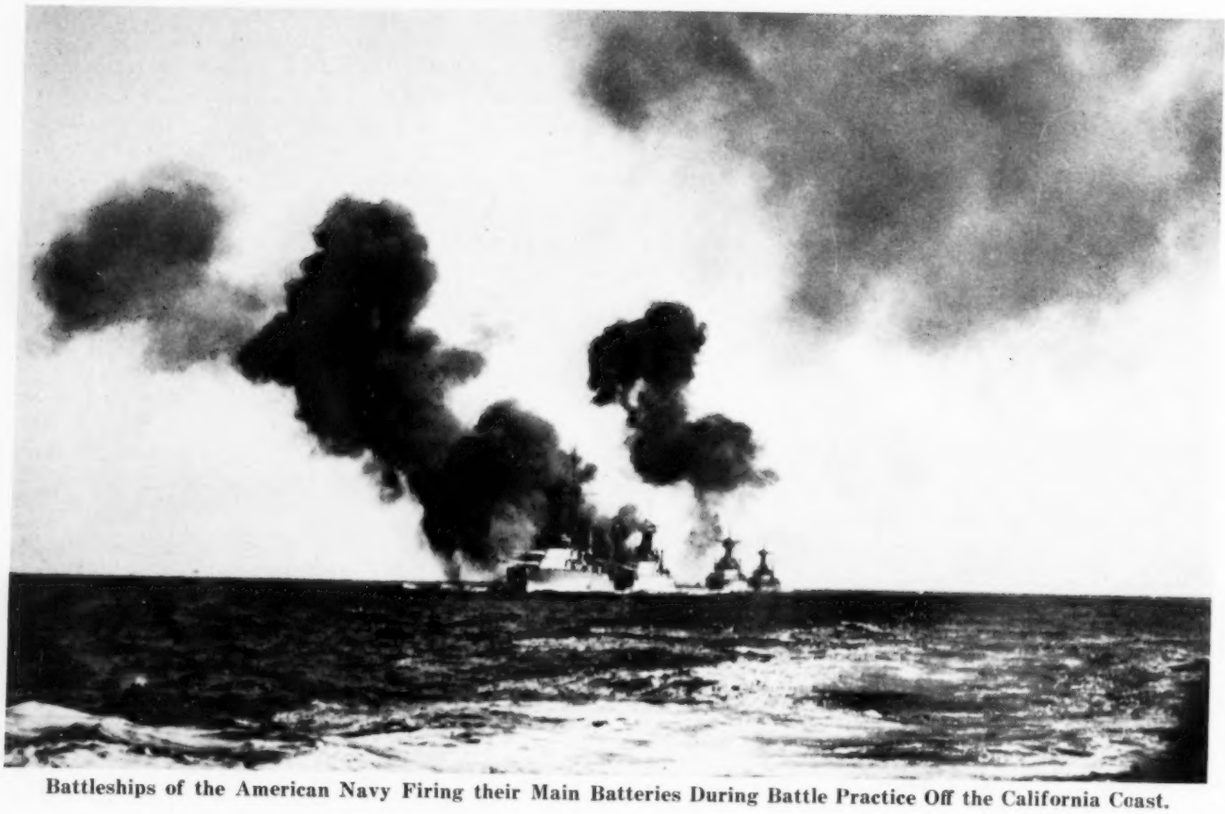
So far as the submarine menace is concerned, this might be greatly reduced by establishing freedom of the seas for merchant shipping, as was proposed at the Naval Conference of 1930. The United States, as well as France and Italy, were heartily in favor of this, and no doubt Japan would gladly have entered into the matter affirmatively, but England objected and agreed to allow submarines to sink merchant ships on trade routes "providing that, in the judgment of the submarine commander, there are other cargo ships available to pick up the unfortunate crew in the open boats, or land is near enough for them to reach it." Such action as this is hardly understandable in view of what happened to British shipping during the recent war. With reference to both international law and the laws of humanity, this was undoubtedly a very peculiar agreement. This same conference failed to do anything about the use of aircraft, but the Washington Treaty of 1921, recognizing this new menace, attempted to formulate some means for regulating the actions of aircraft. Unfortunately the regulations there formulated were not ratified by all the Powers, and they therefore were ineffective. The Disarmament Conference which opened at Geneva in February again has on its agenda the regulation of aircraft. The attempt will be made to limit airplanes by restricting the number and allowable horsepower, while dirigibles are to be limited in number, total horsepower and total volume. The stumbling block here no doubt is the question of how military flight strength can be limited without also limiting commercial planes which may readily be used in war. It is highly questionable whether any nation will be satisfied to throttle the growth of commercial aviation, and quite some consideration has been given this problem without as yet reaching any conclusion.

RETURNING once more to the battleship, and a proposal for scrapping all of these was made by Italy at the 1930 Conference, the question arises as to whether these great floating fortresses have been pushed into "safe harbor" by the airplane as a weapon of warfare, or whether the airplane as a weapon is not even more formidable than the battleship. If I should have to answer this question, I would do so in the affirmative, and I would deem it a very wise policy, and one to be recommended to all Powers, to make scrap iron of all these sea monsters which, in the future, will probably be only museum pieces anyway. I do not know the actual cost of maintaining our battleships at sea, but would suggest that $50,000,000 a year would not be an excessive estimate for the fifteen dreadnoughts of our fleet. At this rate one year's upkeep would purchase at least 500 high-class and superior fighting seaplanes, which will be more needed during a future war than are the ships they would supersede. It would be an interesting study to examine into what would happen to these fifteen battleships if they were to suddenly meet-up with these five hundred fighting sea-planes in war. Think this over!

If all Powers would scrap these monsters, their capital ships would probably be 10,000-ton cruisers, for which there is still some use. Would not the world then be better off economically than with the possibility of building more of these superdreadnoughts after the present agreement has expired? I think so at any rate, and this is a provision which I trust will become a fact some day. As far back as 1886, after the advent of the mobile torpedo, Admiral Aube, of the French Navy, strongly objected to the building of the then prevalent 12,000-ton battleships, feeling the latter had met their masters in this new menace. How much more is this a fact today with the advent of the airplane?

Admiral Sims, who commanded our Fleet in European waters during the Great War, when asked whether the bat-

The Battleship Versus the Submarine



Battleships of the American Navy Firing their Main Batteries During Battle Practice Off the California Coast.

Gun Firing From the Deck of the U. S. Navy Submarine V-4.

tleship would become obsolete due to the appearance of the airplane, answered "It has been said in the past that the battleship was the backbone of the Fleet, but I believe it is so no more. A battleship has no defense against an airplane but small antiaircraft guns. . . . The best experts now agree that the results of antiaircraft firing from a ship are negligible. In my judgment, it matters little whether the big ships now in the world navies are scrapped or left as they are, because in any case they will be of no further use."

Admiral Sims no doubt profited by the lessons the Great War taught, but his statement was probably accepted with a great lifting of eye-brows by some officers who still look upon these great hulks as representing the majesty of the sea, forgetting that little David slew the giant Goliath with a miserable slingshot. Yet the Admiral's statement regarding antiaircraft shooting from a moving, rolling, pitching ship cannot be lightly passed by.

As stated in my previous article, I hardly deem it necessary, in view of our ability to manufacture several hundred airplanes a day, that we provide at once the great air armada which will eventually be required to protect the interior of the United States, our overseas possessions and the Canal Zone, and at the same time supply the Navy with the immense air fleet she will require in time of war. As regards our ground defenses, they should be provided in sufficient quantity to defend our principal centers on the outbreak of war, since they must undertake this duty until the air force is sufficiently organized to spare planes and operators for interior defense.

Pilots, observers and machine gunners must, however, be trained at all times to take care of any eventuality. Airplane-carriers must be provided in sufficient numbers for the Navy, since these vessels cannot be built overnight, and when they are actually needed they should be ready for service and not be on the stocks in some shipyard. As stated in this article, large sums can be saved in providing real protection by scrapping battleships instead of leaning on such weak crutches as superdreadnoughts. Maintaining these, in my opinion, is real unpreparedness so long as the sums thus involved can be put to better service.

LACK of preparedness has always been one of our cardinal sins, and history has repeated itself in every war our Army and Navy have been compelled to fight, hence the following synopsis of some of the travails we were compelled to endure, through this lack, may be of interest.

1. The American Revolution was fought because the time had come to throw off the shackles of despotism and to give birth to a nation of free men. Were we prepared for this war? Read the answer in the snow-covered fields of Valley Forge.

2. The war with France was fought because our young but budding merchant marine was at the mercy of French privateers. This condition became so unbearable that even a peace-loving President and Congress had finally to decide on building a navy, since we had none, and of which Commodore John Barry became the father. This war ended in 1801 with victory for the infant navy, but Congress immediately ordered all but thirteen ships sold, six of those remaining were kept in commission and seven were laid up in ordinary.

3. The Tripolitan War, 1804, was brought on by outrages against our sea-borne commerce. We paid nearly one million dollars to ransom our seamen who were being held in slavery, but then felt maintaining a navy was much cheaper. Here again we had to build another navy before we could put a stop to these outrages. This war over, we find that on April 18, 1806, Congress passed an Act which practically did away with the Navy, and it appeared as if we were about to abandon the sea altogether. All construction under way also was stopped.

4. Soon, however, both France and England were hard at it again, the former capturing our merchant ships and the latter lost no opportunity for forcing American seamen into her service under the guise of their being British citizens. Fortunately affairs in France soon stopped the incipient war with that country. On June 21, 1812, war was declared against England, and this war we fought to establish the freedom of the seas, which was so sadly wrecked by Great Britain during the recent war. We were again compelled to build a navy, but the Treaty of Ghent was signed before these new vessels were ready for service. As regards preparedness on land, suffice it to say that in spite of a total of 528,274 enlistments, we could never properly take care of, or keep armed and equipped, more than 12,000 men at any one time.

5. The Mexican War was fought to straighten out our southern border where a portion of Mexico ran athwart the westward movement of American progress. While not actually prepared for war, the character of the enemy somewhat discounted this, since they were less prepared than were we. We finally made peace and paid Mexico $15,000,000 in cash for the cession of California, Utah, Arizona and New Mexico, and we assumed some $3,000,000 of debts due by Mexico to our citizens.

6. The Civil War was fought to preserve the Union. Our unpreparedness in this case is a matter of history.

7. The Spanish War, of which the least said the better, was fought because we deemed ourselves a nation of saviors, but our unpreparedness for war was a national disgrace.

8. Our unpreparedness, in spite of more than sufficient warning, during the World War should still be fresh in the minds of all, and need not be repeated here.

This has been our history, and in all cases it indicates that we learn but little from the past. I hope, however, that the lessons given us during the recent war will take root and that we will never again be caught asleep should war ever be our lot in the future.

In conclusion permit me to say that these articles, which might be termed "Gasoline in Modern Warfare," were prepared for the sole purpose of attempting to tell the truth as I see it, and to differentiate between it and the somewhat overdrawn statements one so often hears or reads about. In closing I would add a quotation from General M. J. Challéat, as published in the November-December, 1931, issue of this Journal, "Towards the end of the war, thanks to the utilization of tanks, it was occasionally possible to reduce to a great extent and even to eliminate entirely, the artillery preparation preceding to a greater or less degree H-hour designated for the attack. *Nevertheless the attempts to break through the front were never successfully carried out by any belligerent.*"

If the publication and reading of this series of articles will lead to a non-partisan, honest, truthful and constructive discussion, uninfluenced by any personal bias, I will feel I have accomplished my mission. VALE!

Styles in Small Arms Projectiles

An Analysis of the Development of Bullet Shapes—Old and New

By Thomas H. Green*

BEARING in mind the developments in powder charges which took place around 1900 and also the fact that the ballisticians of all the armies of the world were attempting to obtain higher velocity and flatter trajectory about this period it will be readily seen that changes in bullets were bound to become effective. It was generally known that flatness of trajectory could be obtained by projecting a bullet at a higher velocity. It was equally well known that increase in velocity could be obtained by increasing the powder charge or by diminishing the resistance of the bullet or by both. The resistance of the bullet could be diminished, of course, by changes in shape which would effect a reduction of the air resistance or by changes which would diminish the resistance within the rifle barrel. The mathematics and experience with reference to the changes of resistance in the rifle barrel is a study in itself and will only be lightly touched upon here.

Other factors were very strong in creating an incentive for developing the efficiency of bullets. It must be recalled that the competition between the French and the Germans after 1870 was very acute. The militarists of these two nations were permitting nothing to interfere with the efficiency of their armed forces. The Swiss as a nation were and now are unexcelled rifle shots. Not only do they have compulsory military training but they regard target shooting as one of their major sports. The British as a major power having a large standing army, were of course interested in increasing the efficiency of their weapons. The United States during the Spanish War used the round-nosed bullet of about 200 grains which was very similar to the German Mauser bullet. Considerable experimentation had been effected in the United States prior to the Spanish War but during that war large stocks of ammunition were made and after the war development was retarded because of the necessity of using up the war stocks. The Italians appear to have conducted numerous experiments and their publications indicate that they kept abreast of the times. For reasons best known to themselves the Italians have, so far as the writer has been able to find out, retained the round-nosed bullet for their modern service rifles.

THE "Balle D" is a three part bi-ogival bullet comprising a head and intermediate portion and a tail portion. The intermediate portion is of barrel shape and is joined at one extremity by the head portion which is struck on a radius of about 10 calibers. The other extremity is joined by the tail portion which is slightly tapered. The total length of the bullet is 39.2 mm. and the diameter is 8 mm. Its weight is about 12.8 grammes. The first bullets were made for the 8-mm. Lebel rifle and were constructed of lead and jacketed with German silver. The later bullets and those used during the World War were made solid and of a bimetal alloy principally composed of brass.

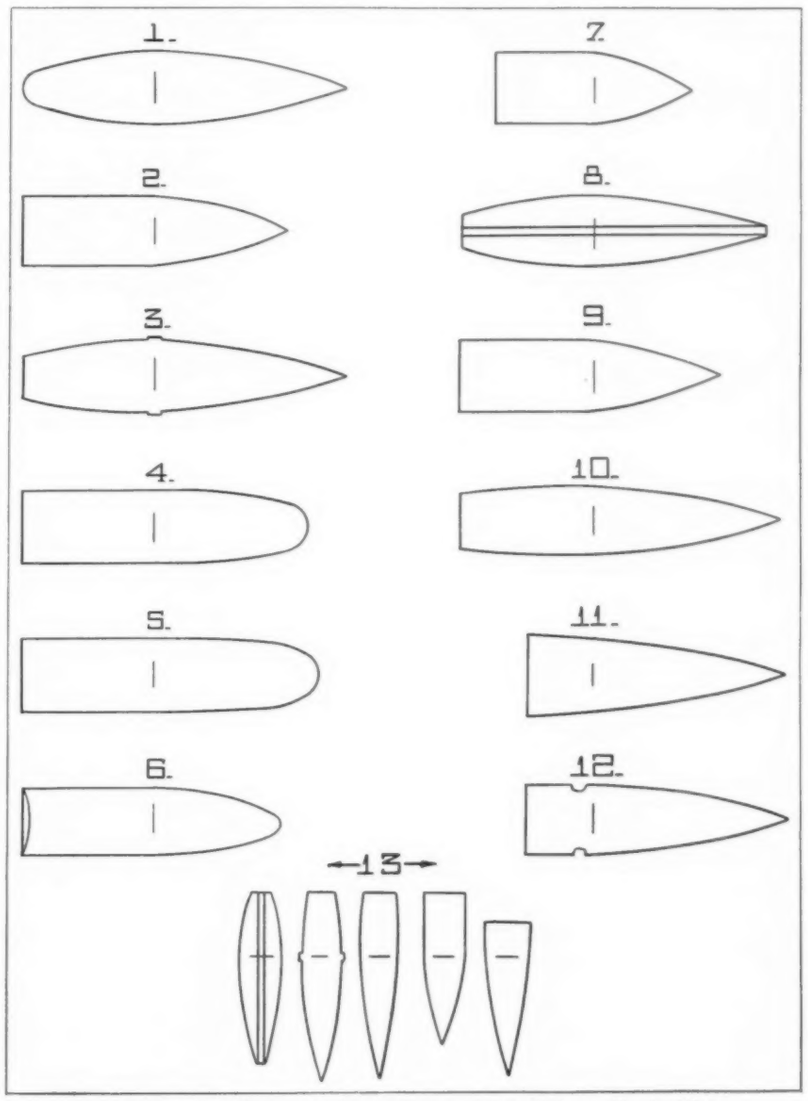
Much of the history of the development of the "Balle D" bullet has been made public. In 1886 the French Army adopted the Lebel rifle which is still the standard hand firearm of France. The French are justly proud of this fact since most of the major powers have repeatedly changed their rifles to keep up with developments. The bullet originally used with this rifle was similar to the Mauser, Krag and other round-nosed jacketed bullets. As early as 1890 the French General Staff decided that the velocity of the bullet must be increased to give a more nearly flat trajectory, greater range and by reason of flat trajectory a greater accuracy at unknown ranges. Up to this time ballistic developments with the French were to a large extent limited to artillery. In the production of their 75-mm. gun it will be readily admitted that their success was great. About 1891 General Desaleaux, then a Major, conceived the idea of applying the well known principles used in artillery shells to the rifle projectile. Apparently he carried the idea around with him for some time and about 1894 submitted a design based upon the Hebler principles and including a combination of the Whitworth shell and the Obus Bange. The Whitworth shell was of English design produced prior to the Civil War and characterized by its extreme length. The Confederate Army had two or more Whitworth guns and shells therefor which they used with a great deal of efficiency during the Civil War and most effectively at the Battle of Gettysburg. The Obus Bange, as has been stated before, was the head portion of a French artillery shell characterized by having a very long ogive. In 1897 official studies were made of the Desaleux bullet at the Small Arms Factory of the French Army at Versailles. In 1898 the experiments were completed and the bullet was designated as the Model 1898. In 1899 manufacture of the bullet began. In 1898 also the bullets of this character were issued to certain troops for experimental purposes. The general issue of this bullet was approved under date of April 23, 1901. On July 8, 1904, the secrecy ban was lifted from the bullet and the news was officially published to the world. Prior to this time Paris buzzed with rumors with reference to the new and extraordinary bullet. Unquestionably attachés of foreign countries on duty in Paris were familiar with the characteristics of this bullet as early as 1902. On this question French officers very aptly remark that when one issues equipment to troops, even experimentally, it may no longer be kept secret.

As an example of the effectiveness of the attempted secrecy by the French an article is cited which appeared in the *La Patrie* of September 23, 1903, a Paris newspaper from which the following is quoted: ". . . Two years ago General de Gallifet, at the tribune of the Chamber of Deputies, stated: 'From this day on, the French Army is endowed with an improvement which doubles its power, and which shall make it tomorrow superior to the strongest European army' . . . . One was soon to learn that the improvement in question was a new bullet. . . . The new bullet is in a case similar to that of the former. It is very pointed, longer and lighter than the former by a few grammes. The in-

*Captain, Judge Advocate General's Department, U. S. Army. Part I of this article was published in the May-June, 1932, issue of this Journal. This instalment concludes the discussion.

crease in the powder charge and in the length of the cartridge has been obtained without changing the chamber of our 1886 rifle."

It can be readily seen that the hope of the French Army to keep its discovery secret was ruined by this publication, if not before, since the foregoing clearly describes the essentials of the new bullet to those skilled in the art. It is a well known saying among investigators in Europe, particularly as to subjects which either the French or the German authorities desire to keep secret, that if you desire to know what the French are doing you should read the German periodicals and vice versa. Some of the French periodicals issued prior to the World War contend very strongly that the Germans merely copied the French bullet and adopted it to the German rifle. On the contrary German publications contend that the Germans discovered a new ballistic principle and gave it to the world.



Important Developments in the Form of Small Arms Projectiles.

Fig. 1. Piobert; Fig. 2. Warren; Fig. 3. Farley; Fig. 4. French Model 88; Fig. 5. Mauser (German); Fig. 6. Krag (U. S.); Fig. 7. Jacobs (English); Fig. 8. Hebler (Swiss); Fig. 9. Gleinich (D. W. F.); Fig. 10. Balle D (French); Fig. 11. "S" Bullet (German); Fig. 12. Model 1906 (U. S.).

A comparison of Figures 4 and 10, 5 and 11, and 6 and 12 shows the post World War and war-time bullets of the French, German, and United States respectively. Figure 13 permits a comparison of the form of the Hebler, Farley, Balle D, Gleinich (D. W. F.), and "S" bullets.

There are numerous publications which give ample evidence that not only Germany but the rest of the world was familiar with the "Balle D" bullet prior to 1904. The first public information as to the German "S" bullet however was in 1904.

THE German "S" bullet is a two-part bullet, 28-mm. long. The head portion comprises about two-thirds of the total length and the body portion comprises one-third of the total length of the bullet. The base portion is 8.22 mm. in diameter and at the point where the head and body join has a diameter of 8.14 mm. The head portion is struck on a radius of approximately 6 calibers. The body portion is conical in shape, for the purpose of facilitating the ejecting of the bullet from the mold.

This bullet was officially adopted by the Germans in February, 1904. The circumstances with reference to the adoption of this bullet are not altogether clear. The credit for the "S" bullet has been claimed for Herr Arthur Gleinich, an employee of the Deutsche Waffen und Munitions Fabriken. The employers of Gleinich appear to have been working with the German War Department in connection with the design of a new bullet. So far as can be learned experiments were begun by Gleinich in 1902 and continued until February, 1904, when he applied for a patent on a bullet, the characteristics of which were that it was a two part bullet comprising a head and cylindrical body of equal length, the head being struck on a radius of from 4 to 9 fold the caliber. Somewhat similar patents were applied for by Herr Gleinich in practically every nation of the world, including the United States. The bullet invented and patented by Gleinich seems to be quite different from that adopted by the German army in that the Gleinich bullet had a head and body portion substantially equal whereas the German army bullet has a head occupying substantially 2/3 of the total length. The Gleinich design had a cylindrical body the diameter of the distance between the grooves, and the German army bullet had a conical body the forward portion having a diameter equal to the distance between the lands and the rear portion having a diameter equal to the distance between the grooves.

Considerable litigation was had with reference to the German patent. In 1906 an action was brought against the owners of the patent alleging that it lacked novelty over the prior art and should therefore be annulled. The litigation went to the Supreme Court of Germany which by its decision held that the patent was valid. During the process of this litigation the owners of the patent made some curious claims that are worth recording. It was claimed that the term "body" or "guide portion" should be construed to include not only the actual body but that portion which would be cut by the lands of the rifle through which the bullet was fired. As defined by the owners of the patent the body was that portion cut by the lands and the head was that which remained uncut. In view of the fact that there is a decided swedging of the bullet upon being fired, and the extent of cutting by the lands would depend upon the exactness of each rifle and bullet and the condition of the rifle barrel as to erosion and other factors it will be readily seen that the proportion of a bullet measured by the suggested rule would be variable indeed.

Corresponding patents were filed in nearly every country. For some reason those filed in England, the United States, and other countries differed from the German patent in that they related to a bullet having a cylindrical body. The records of experiments of Gleinich furnished to the United States Patent Office in connection with the application for patent indicates that the bullets used by Gleinich in his experiments were at least 200 grains in weight and had a head and body portion substantially equal. The "S" bullet adopted by the German army was substantially different in weight and form. A scientific and careful comparison of the "S" bullet and the D. W. F. or Gleinich bullet may be found in *Revue d'Artillerie* (Paris, France) for December, 1905, most of the information being taken from German publications. The Gleinich German Patent, No. 204,660, was issued February 21, 1904. The corresponding American Patent, No. 841,861, was issued on January 22, 1907, and reissued as No. 12,927 on March 16, 1909.

SINCE the "Balle D" and the "S" bullets were the first European bullets to be adopted which were characterized by having long pointed head portions, and since the United States Model 1906 caliber .30 bullet is somewhat similar to the "S" bullet, a comparison of the "S" and "Balle D" bullets in operation as well as contour should be of interest. The French views of the matter as concern the physical qualities, are set out in many publications. The following quotation from the publication "The Balle D Bullet," page 43, will suffice as an example: "Since the adoption of our 'D' bullet in 1904, the German armament was notably inferior to ours. The Mauser 1898 still used the 1888 cylindro-ogival bullet weighing 14 grammes 70 with an initial velocity of 635 meters and almost identical to our M bullet.

"When our 'D' bullet appeared, the Germans knew of it immediately and started to make researches for a new shaped bullet. They found the 'S' bullet thus called from the first letter of the word 'Spitzgeschoss' (pointed projectile). It was adopted in 1905. However, Germans state with great energy that they did not copy our 'D' bullet. However, it is without a doubt that bullet that they used as a model. It resembles exactly the 'D' bullet if one cut off the base on a length of 11 mm. If one superimposes the drawings of both bullets, one sees that they coincide perfectly. . . .

"Point—the 'S' and 'D' bullets have the same point: 20 mm. in length and almost the same diameter at the base: 8.14 and 8.20.

"For the 'S' bullet, the point represents 2/3 of the total length; it represents 1/2 of the length of the 'D' bullet. It was formerly stated commonly that the point should never be more than one-third of the total length. Now, both the S and the D bullets keep a perfect balance on their trajectory, and thus a severe rule of ballistics is set aside.

"This very slender point enables the bullet to conquer more easily the air resistance, which is all the higher as the initial velocity is greater."

A comparison of the action of the two bullets is particularly interesting since the Model 1906 caliber .30 bullet used by the United States Army during the World War had the general characteristics of the "S" bullet. At short ranges the "S" bullet and the Model 1906 United States bullet appear to be more accurate than the longer, heavier "Balle D" bullet, but on the longer ranges the "Balle D" comes into its own. An interesting discussion on this subject is found in *Larousse Mensuel Illustré,* a periodical covering the period from 1914 to 1917.

A comparison of the "Balle D" and the "S" bullets is also found in *Kriegsiechnile Zeitschrift* published in Berlin in 1905. It is singular that during the World War the Germans changed their bullet from the form originally adopted and added to it the boat tail. The bullets so constructed were very similar in appearance and mathematically quite similar to the French "Balle D" bullet.

FOREMOST among the ballisticians of Switzerland were Professors Krnka and Hebler. These gentlemen were among the earliest to decide on a long pointed bullet for use in rifles. They conducted a great many experiments and finally developed and patented a long bullet, the ogive of which was probably 15 calibers. This bullet had a central passage running through its longitudinal axis which was intended to diminish air resistance by permitting the air to flow through the passage in the center of the bullet. The bullet also was intended to be fired with a sabot. This bullet was patented by the inventors in 1893 in England, the United States, and Switzerland. It was this bullet which formed the basis of some of the early experiments by the Americans and the works of Professors Hebler and Krnka prior to this time were well known by French authorities. There were many other authorities on the subject among the Swiss and an investigation of that field should be profitable.

AS hereinbefore stated the Spanish-American War probably delayed the development of the military projectiles in the United States to some extent. There were, however, a number of studies conducted by the Ordnance Department on the subject prior to that war. These studies are recorded in the Ordnance Construction Notes covering the period from 1894 to 1898. One of the outstanding experiments conducted during this period was the design and test of the Farley bullet.

In 1894 Colonel Farley who was in charge of the small arms division of Frankford Arsenal ran some tests on the Krnka-Hebler bullet, to which reference was made in this paper under the development by the Swiss. It is to be remembered that this bullet was a long bullet having an

air channel passing through its longitudinal axis and intended to be shot with a sabot. The tests of this bullet indicated that it was not as efficient as the bullet then in current use. Apparently the experiments with this bullet led Colonel Farley to design a bullet characterized by having a long pointed head and a slightly receding body portion. The ogive of this bullet was probably 10 times the radius. To facilitate the experiments these bullets were constructed of steel of the diameter of the distance between the lands of the rifle, and then, to produce proper contact with the lands, a rotating band of copper was shrunk on about the diameter of the bullet. The first test of bullets of this character is reported on page 89 of the Annual Report of the Chief of Ordnance for the Fiscal Year ending June 30, 1894, published by the Government Printing Office in 1895. The Farley cartridge as fired was loaded with 42 grains of Leonard J. powder and the bullet gave a radius of circles of shots of 1.5. The only original bullets of this character are in the possession of General John Pitman of Orange, New Jersey. In passing, it may be stated that General Pitman, a retired Ordnance officer, has for many years been a collector of firearms and small arms projectiles and among his outstanding collections are many original bullets and records pertaining thereto which are not obtainable elsewhere. Although the Farley bullet showed by its tests to have possibilities, except for experiments conducted by individual officers of which there remain no exact records, no extended experiments in this line were conducted until the close of the Spanish-American War.

THE records of the War Department indicate rather conclusively that Ordnance officers and others in 1902 and 1903 were aware of the characteristics of the French "Balle D" bullet. In 1904 the Germans announced the adoption of their "S" bullet and obviously the ballisticians of this country were aware of its characteristics at this time, if not before. As is usual in most cases, various rumors and speculations as to the value of these two foreign bullets had been more or less common talk for some time prior to 1904. It appears that as a result of its experience in the Spanish-American War the American Army was convinced of the necessity of increasing the velocity of its bullets. At that time the present Chief of Ordnance, Major General Samuel Hof, was on duty at Frankford Arsenal in charge of the small arms projectile division. It was this officer who designed the Model 1906 caliber .30 bullet. The following extract is quoted from a recent statement by General Hof in connection with a legal proceeding on the matter:

"I had charge of designing the Model 1906 caliber .30 United States Army bullet, which was the standard bullet used by the United States Army from 1906 to 1925. I designed the bullet under the following circumstances:

"From 1904 until 1908 I was stationed at the Frankford Arsenal, where I was in charge of the Small Arms Ammunition Department. I was familiar with and had made a study of the various types of bullets and cartridges that had been used by various armies, as well as of the literature on the subject. I also investigated various types of experimental bullets. As a result of my studies I had become familiar with the pointed bullet, since pointed bullets were manufactured at the Frankford Arsenal as early as 1894, the bullet of that year being known as the Farley bullet. I was familiar with and had seen the Farley bullet. It was a pointed bullet and had been not only manufactured, but thoroughly tested and reported on to the Secretary of War. I was also familiar with the comprehensive studies made of the characteristics of small arms bullets, which are contained in Ordnance Construction Notes covering the period 1894 to 1898, in which the advantages of pointed bullets were pointed out, shapes, velocities, etc., being dealt with in detail.

"I was also familiar with the French pointed bullet, which had been adopted in 1898 and which was known as the Lebel bullet or the "Balle D," samples of which were at the Frankford Arsenal as early as September, 1903.

"Late in 1904 I received instructions from the Ordnance Department to design a new bullet for the Model 1903 rifle, otherwise known as the Springfield rifle. Naturally, because of my knowledge of the developments and experiments which I have just referred to, I designed a pointed bullet for that purpose, because that was the type of bullet from which we could obtain the highest velocity, with added advantage, as well as flat trajectory.

"The design of the bullet was worked out under my direction, the different dimensions being adopted for the purpose of making the bullet suitable for the Springfield rifle. Most of this work was done in 1905, and was completed early in 1906, and that was the reason why the new bullet was called the Model 1906 bullet."

AS approved in 1906 the Model 1906 caliber .30 bullet had a very long head portion and a very small cylindrical portion. The balance was not as accurate as desired and after experimenting the cylindrical or body portion was increased in length to approximately one-third of the total length. In 1916 powder manufacturers complained that under the stress of war, accuracy was difficult and more liberal specifications were requested. To comply with the war conditions the cylindrical portion of the bullet was slightly decreased in length and has remained a little less than one-third the total length of the bullet. The dimensions and appearance of the Model 1906 bullet are so well known as to make a description of them unnecessary. As is well known, in 1924 the Ordnance Department redesigned the bullet and added the boat tail for the recognized purpose of increasing the efficiency of the bullet.

The English bullet as adopted in 1906 was somewhat similar to the German "S" bullet and the United States Model 1906 bullet. The British likewise have adopted the boat-tail bullet. At the present time the service bullets of the United States, Germany, England and France are remarkably similar in appearance. In principle they are substantially alike and vary only as is necessary to meet varying conditions and to attain what each nation considers the greatest efficiency.

The era of about thirty years following the reduction to practice of the ideas of Desaleaux, Farley, Krnka, Gleinich, Hof and other ballisticians has brought great developments in projectiles for use in small arms and with the armament used in connection with tanks and armored cars it is probable that within the next thirty years a similar increase in efficiency will be attained. Already there are rumors that fantastic velocities in rifle projectiles have been attained. There has been considerable definite information on the subject but there are still many difficulties to overcome before the desires of present-day ballisticians will be satisfied. (*Conclusion. Part I was published in the preceding issue.*)

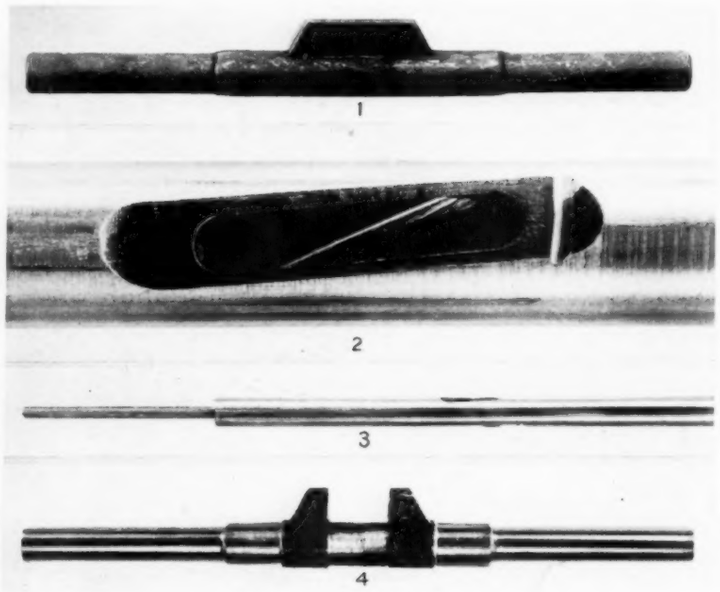
Principles of Firearms Identification

Further Analysis of Accidental Characteristics

By Charles O. Gunther*

IN an article published in the March-April, 1932, issue of ARMY ORDNANCE, the author pointed out that class characteristics determine the type and make of firearm, and that accidental characteristics are the final determining factors of the identity of the particular firearm.

From a microscopic examination and analysis of the marks, impressions and deformations on a discharged cartridge case, it is possible to determine the accidental characteristics of some of the following component parts, according to the type, of the firearm in which it was discharged: (a) breech block or recoil plate, i. e., the surface with which the base of the cartridge case comes in contact under the pressure developed by the powder gases; (b) firing pin; (c) circumference of hole through which the firing pin strikes; (d) nose of hammer; (e) extractor; (f) ejector; (g) magazine, and (h) surface of slide which comes in contact with the base of the cartridge case in the process of feeding the cartridge from the magazine into the chamber of the particular piece.



Rifling a Pistol Barrel.

Fig. 1. Barrels for Automatic Pistol Drop Forged in Pairs; Fig. 2. Rifling a Barrel with a "Scrape" Cutter; Fig. 3. Longitudinal View of Rifling Head with Two Cutters and Wedge in Place; Fig. 4 Rifled Barrels Before Separation.

From a microscopic examination and analysis of the engraving on the cylindrical portion of the bullet it is possible to determine the accidental characteristics of the bore of the firearm from which the bullet was fired. What constitutes accidental characteristics in the bore of a new barrel may perhaps be best understood by reviewing the operations incident to the manufacture of barrels, and more particularly, the methods adopted by the Ordnance Department in the manufacture of barrels for the automatic pistol, caliber .45, Model 1911, U. S. Army.

The barrels are drop forged in pairs from a rectangular bar of hot rolled manganese steel. These forgings (Fig. 1) are then subjected to the following operations: 1. Annealing, 2. Pickling, 3. Trimming, 4. Inspection, 5. Heat treating (Quench in oil. Draw.), 6. Test for hardness, 7. Pickle, 8. Straightening (when necessary), 9. Inspection, 10. Burring, 11. Mill between lugs, 12. Mill ends, 13. Center—both ends, 14. Rough turn ends, 15. Rough turn between lugs, 16. Inspection, 17. Shouldering, 18. Inspection, 19. Drilling bore, 20. First reaming of bore (2 reamers), 21. Inspection, 22. Finish turning, 23. Inspection, 24. Grinding body, 25. Inspection, 26. Second reaming (rough—2 reamers), 27. Third reaming (finish—3 reamers), 28. Inspection.

The barrels are now ready for the rifling operation. The rifling consists of six helical grooves cut in the surface of the bore with a uniform left-handed twist, making one complete turn in 16 inches. The barrels are rifled with what is known as a "scrape" cutter. Figure 2 shows a close-up view of one of these cutters in place in the rifling head. The length of the cutting edge is 0.45-in. and the width of the finished groove is 0.1522-in. and hence the ratio of groove width to length of cutting edge is approximately 1 to 3. Fig. 3 shows a longitudinal view of the rifling head with the two cutters and wedge in place. The cutters are elevated by means of the wedge shown entering the left end of the rifling head.

FOR convenience of explanation, the consecutive grooves of the bore will be referred to by the numbers 1 to 6, inclusive, and the cutters will be designated by the letters A and B. Cutter A has one corner knocked off and cutter B has the opposite corner knocked off so that when the rifling head is passed through the barrel the first time, cutter A cuts one corner of groove 1 and more than half the groove width while cutter B cuts the opposite corner of groove 4 and more than half the groove width. After the cutters have passed through the barrel and back in the same groove, the barrel is rotated one-sixth of a turn and the rifling head passed through the barrel and back for the second time making the initial cuts of grooves 2 and 5. The barrel is again rotated one-sixth of a turn and the initial cuts of grooves 3 and 6 are made on the third pass of the rifling head.

The barrel is again rotated one-sixth of a turn and the rifling head passed through the barrel and back for the fourth time, cutter B completing the initial cut of groove 1

*Professor of Mathematics and Consulting Engineer, Stevens Institute of Technology. Lieutenant Colonel, Ordnance Reserve, U. S. Army.

and cutter A the initial cut of groove 4. After the barrel has been rotated one complete turn and the rifling head has passed through the barrel and back six times, the initial cuts of all six grooves have been completed. The wedge is now fed in the proper distance to elevate the cutters for the next cut and the cycle as described is repeated until the grooves have been cut to the proper depth. The wedge is fed in approximately seventy times during the rifling operation so that the rifling head passes through the barrel and back approximately 420 times. After the required depth of groove has been obtained, the rifling head with cutters remaining set at that position is allowed to pass through the barrel and back for approximately 15 minutes as a smoothing operation. About five barrels (double) can be rifled before the cutters require regrinding. Recently the use of double cutters was discontinued and pistol barrels are now rifled with a single cutter.

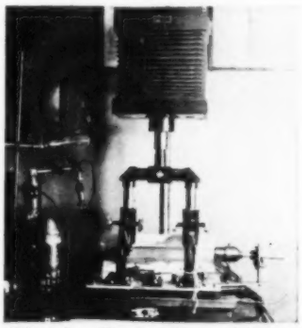


Fig. 5. Comparison Microscope with Camera Attached.

At this stage the barrels appear as shown in Fig. 4. The rifling operation is followed by the following in the sequence given:

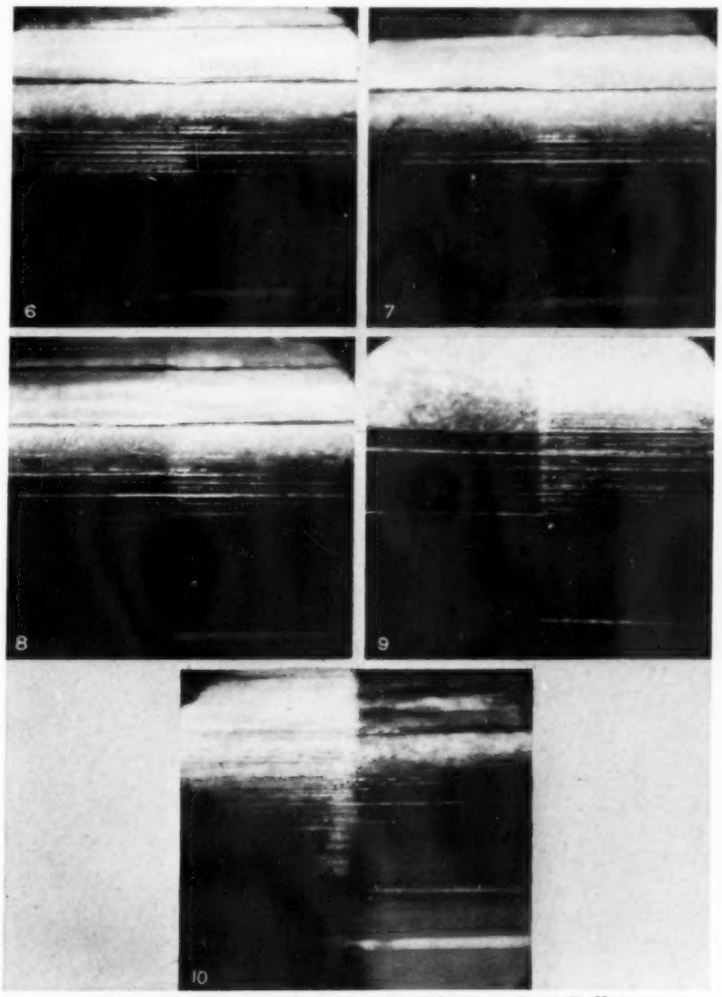
1. Inspection, 2. Cut in single lengths, 3. Inspection, 4. Face rear end, 5. Chamfer both ends, 6. Inspection, 7. Mill right and left sides, 8. Inspection, 9. Rotary mill rear end of lug and taper on barrel, 10. Burr rear corner of lug, 11. Inspection, 12. Hand mill face of breech, 13. Inspection, 14. Drill and ream link pin hole, 15. Burring, 16. Form front of lug to shape, 17. Burring, 18. Mill radius on bottom of lug, 19. Mill locking grooves, 20. Inspection, 21. Mill link slot, 22. Grind top of breech, 23. Burring, 24. Inspection, 25. Chamber, 26. Inspection, 27. First polishing (approximately 2 in. of muzzle end), 28. Chamber over breech end, 29. Mill headspace, 30. Burring, 31. Inspection, 32. Mill cartridge clearance cut, 33. Inspection, 34. Face muzzle to length, 35. Inspection, 36. Second polishing (finish), 37. File and corner, 38. Inspection, 39. Carbonia black, 40. Proof fire, 41. Cleaning, 42. Stamp—proof mark, 43. Grease (rust preventive compound).

The breech ends of the lands are chamfered to form the forcing cone through which the bullet is led into the bore. The lands rise to their full height of 0.003-in. in a distance of 0.086-in. from the beginning of the bullet seat.

It is interesting to note that the interior surfaces of a pair of barrels manufactured in accordance with the operations enumerated above will be quite different from each other and for the following specific reasons:

First, in chambering the separated barrels, approximately 2 inches of the rifling at the center of the double barrel is removed and therefore there will be a difference in phase of about one-eighth of a turn or 45 degrees between the breech ends of the corresponding grooves in the two barrels when they are placed in the position occupied before separation as shown in Fig. 4.

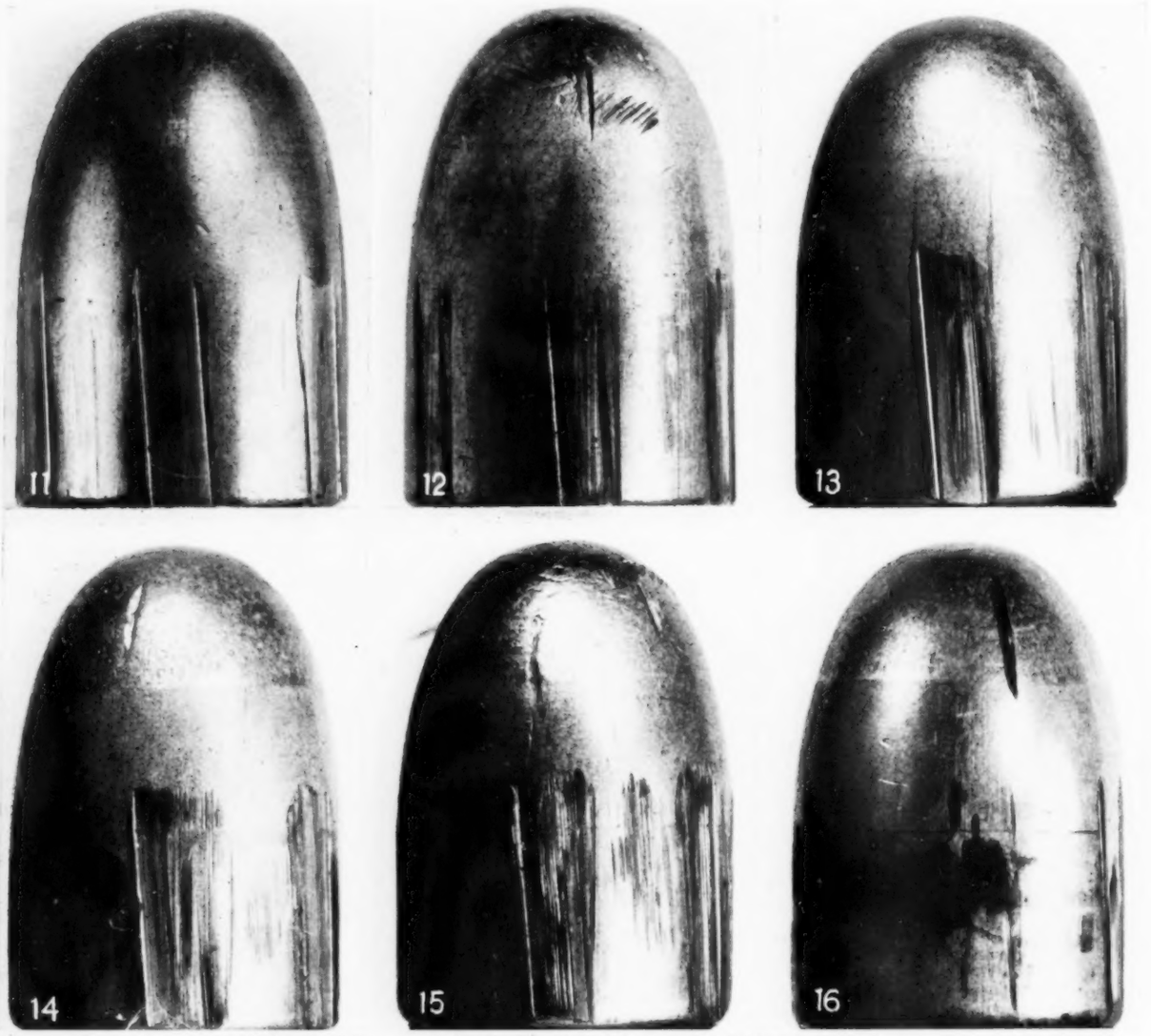
Second, if the successive grooves at the right hand end of the double barrel in Fig. 4 be numbered 1 to 6 in a *clockwise* direction, then these same grooves will carry through to the left-hand end of the double barrel with the numbers 1 to 6 in a *counter-clockwise* direction. In other words, bullets passing through these barrels when separated will *rotate in opposite directions with reference to the axis of the double barrel,* and the driving edges of corresponding lands in the two barrels will be reversed. In one of the separated barrels the driving edges of



Photomicrographs of Groove Markings on Test Bullets.

	Left Bullet No. 2	Right Bullet No. 3
Fig. 6	Groove 1	Groove 1
Fig. 7	Groove 2	Groove 1
Fig. 8	Groove 4	Groove 1
Fig. 9	Groove 4	Groove 1

Fig. 10. Similarity of groove markings on two bullets fired in a rifle of the same manufacture as that used in Figs. 6 to 9 but produced about seven years later.



Bullets Fired From Automatic Pistol, Caliber .45, Model 1911, U. S. Army.

Fig. 11. Bullet fired from new barrel; bore diameter at muzzle 0.4449-inch, 1-inch from muzzle 0.4447-inch. Fig. 12. Bullet fired from barrel manufactured by Colt's Patent Fire Arms Manufacturing Co.; bore diameter larger at breech than at muzzle. Fig. 13. Bullet fired from used barrel of which land impression shows effect of erosion. Fig. 14. Bullet fired from barrel in which erosion had reached stage of unserviceability for accurate shooting. Fig. 15. Land impression on bullet shows effect of corrosion. Fig. 16. Undersized bullet which made little contact with lands; black area is the result of escaping powder gases.

the lands will have been cut by cutter A while those of the second barrel will have been cut by cutter B.

Some manufacturers use a "hook" cutter in rifling barrels. The cutting edge of this type of cutter lies in a plane perpendicular to the axis of the bore and the ratio of length of cutting edge to groove width is unity. In barrels rifled with a single cutter, all grooves are formed by the same cutting edge unless the cutter is removed during the operation and reground.

In studying the engravings on metal-jacketed bullets fired in a caliber .32-20 rifle, the barrel of which was rifled with a hook cutter and not lapped, it was found, at least to the extent indicated by the engravings on the surfaces of the bullets, that the tool marks were reproduced in all six grooves.

Photomicrographs were made with the apparatus shown in Fig. 5 in which the camera body is attached to the comparison eyepiece bridging the two microscopes. With the camera body swung back the apparatus is available for visual use. The whole apparatus rests on sponge rubber pads to eliminate vibration. One of the test bullets was placed under the microscope on the right showing the engraving on its surface made by one of the grooves in the barrel. The second test bullet was then placed under the microscope on the left and the engravings on its surface made by the six grooves of the barrel successively matched with the engraving on the surface of the bullet on the right. Some of these photomicrographs are shown in Figs. 6 to 9.

If more than one barrel was rifled with this same cutting edge before it was reground, bullets fired from these barrels would probably show this same duplication of groove tool marks.

A second rifle of the same make manufactured about seven years later was next examined. A similar comparison of two bullets fired in this second rifle indicated considerable reproduction of rifling tool marks in the six grooves, and,

curiously, a photomicrograph (15x) of a comparison of the engraving on the surface of one of these test bullets shown on the left in Fig. 10 with the same engraving shown on the right in Figs. 6 to 8, produces an interesting similarity.

The reproduction of groove tool marks creates a situation which is not only serious but extremely significant and conveys a warning that may not be ignored. Such reproduction is evidently dependent upon the physical properties of the metal constituting the cutter in comparison with the physical properties of the steel of the barrel; the relative hardness of the rifling cutter and the steel of the barrel as well as upon the method of rifling; the probability of reproduction is greatest when the ratio of the cutting edge to groove width is unity. The probability of reproduction decreases as the number of "teeth" in the cutting edge increases. Lead lapping a barrel will to a large extent destroy the evidence of the reproduction of the rifling tool marks.

IT is probably true that no two newly manufactured barrels of the same class characteristics will have the same accidental characteristics; but not all accidental characteristics of a barrel can be determined from an analysis of the engraving on the surface of a bullet fired from it. For example, if barrels of the same class characteristics are subjected to precision measurements (at constant temperature) to one hundred thousandths of an inch, such measurements will show variations in the dimensions of the cross-sections of the bores of the barrels from breech to muzzle. On the other hand, such variations can not be determined from bullets fired through the bores of the barrels. When consideration is given to the differences existing in the coëfficients of expansion of steel, lead, copper, zinc, tin, antimony; the plasticity and elasticity of metals and alloys; the shock effect produced when the bullet comes in contact with a resisting medium; one can readily understand that a bullet is not an appropriate object for precision measurements. No positive identification as to the firearm from which a bullet was fired is possible from measurements made with the bullet; such measurements are only useful in establishing the class characteristics of the firearm from which the bullet was fired.

In the Sacco-Vanzetti case an attempt was made to show that the mortal bullet could not have been fired from Sacco's pistol because the dimensions of the cross-section of the bore of the pistol at the muzzle did not agree with the corresponding dimensions obtained from the mortal bullet. As a matter of fact, if it had been shown that these dimensions were in perfect agreement, this would have furnished a sound basis for proving the desired contention.

The portion of the cylindrical surface of the bullet which comes in contact with the lands in its motion through the bore is subjected to the greatest radial compressive forces and therefore accidental characteristics of the surfaces of the lands and land shoulders which are apparent from a microscopic examination of the bullet are the most reliable from the standpoint of identification.

The bullets shown in Figs. 11 to 16 were fired from different barrels in an automatic pistol, caliber .45, Model 1911, U. S. Army. The bullet shown in Fig. 11 was fired from a new barrel manufactured at Springfield Armory. The bore diameter of this barrel measures 0.4449-in. at the muzzle and at 1 inch from the muzzle the diameter is 0.4447 in., and this dimension continues on to the breech.

The bullet shown in Fig. 12 was fired from a barrel manufactured by the Colt's Patent Fire Arms Manufacturing Company. As indicated by the land impression on the bullet, the bore diameter of this barrel is slightly larger at the breech than further along the bore to the muzzle.

THE bullet shown in Fig. 13 was fired from a barrel which has had considerable use and the land impression shows the effect of erosion, and the bullet shown in Fig. 14 was fired from a barrel in which the erosion had reached the stage at which the barrel was no longer serviceable for accurate shooting.

The land impression on the bullet shown in Fig. 15 shows the effect of corrosion; this barrel had not been given any attention for many years prior to which it had been used very little.

The bullet shown in Fig. 16 was under size and made very little contact with the lands. The black area is the result of the action of the powder gases escaping under high pressure and temperature.

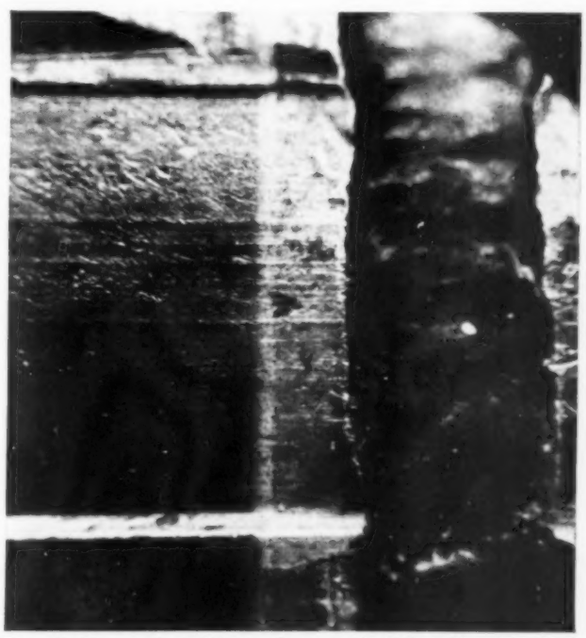


Fig. 17. Comparison Photomicrograph (30x) Showing Accidental Characteristics on the Lands of a Test and a Fatal Bullet.

The existence of accidental characteristics on the surface of a land and its shoulders in a Colt revolver is clearly shown in Fig. 17 which is a photomicrograph (30x) of a comparison of one of the land impressions on a test bullet fired from a suspected weapon (Colt revolver, Cal. .38 S & W Special) with a land impression on a fatal bullet. The test bullet is shown on the left of the illustration and the fatal bullet on the right.

In the middle third of the land impression are a number of lines which carry through on both bullets and these lines appear on every bullet fired from this revolver. The location and spacing of these lines is of random distribution and the probability of exact reproduction in another revolver of the same class characteristics is very remote.

A similar comparison of all the land impressions in rotation indicated positive agreement of accidental characteristics.

ARMY ORDNANCE

Published Bimonthly by
THE ARMY ORDNANCE ASSOCIATION
Washington, D. C.

JULY-AUGUST, 1932

Month by Month

IT seems that there is little harvest to be gleaned from mechanized activities in the fighting between the Japanese and Chinese early in the year. Long-distance observers had assumed that the encounters, particularly those around Shanghai, would present object lessons in the use of modern engines of war especially tanks, armored cars and airplanes. Such as they are, the conclusions to be drawn are not many. We might attempt to outline them as follows:

With the Tanks at Shanghai

There was street fighting in the built-up city of Chapei and there was open-country battle. In the streets a few armored cars were used but not very effectively. This was perhaps because in the narrow streets with overhanging houses these vehicles were regarded as too vulnerable to hand grenades and bombs. At all events the Japanese made practically no progress in the town for weeks until the Chinese withdrew some distance away because they were outflanked.

Tanks were used in the open country but the terrain was very unfavorable. Topographically impeded by numerous ditches and canals the tanks could advance only along the roads. They did nothing at all notable although it is understood that none was put out of action by artillery fire or bombs. As in the open country, so also against the Chinese trench positions the Japanese made no significant advance. In the engagements the tanks must be considered a failure as a means of breaking an infantry and machine-gun line. The Japanese got forward only when the outflanked Chinese retired; the outflanking having been effected by landing troops behind their left flank, up the Yangtse. The Chinese did nothing with artillery but the Japanese employed theirs a good deal. The Japanese also made much use of airplanes, bombing from low heights, but without dislodging the Chinese.

Two things seem to have come out of the encounter: the Japanese exhibited much less dash and much poorer organization of their attack than we have been in the habit of crediting them with; and the Chinese have shown—much to the surprise of everybody including themselves—that they will not run away but will stay in their trenches and fight when decently encouraged. In Manchuria they had disintegrated and scattered like glass balls whenever they were struck by the Japanese no matter what the relative numbers.

The whole Shanghai incident has brought a distinct disadvantage to the Japanese. Before it, negotiations between them and the Chinese were carried on in an atmosphere of belief, by both sides, that the Chinese could offer no resistance to a Japanese military advance. Now it is realized by both that the Chinese can make such an advance costly at least. At Shanghai, however, the tanks had little or no opportunity to perform so the first post-World War test of the newcomer in actual battle is yet to be staged.

THE history of armament is the history of metals and explosives. Through metallurgical research and test the defense services of many nations have given much to commercial and economic development of the world and civilian effort has contributed a mede of progress utilizing military experience. In no field is this more strikingly true than in the applied science of metallurgy and to no one man today is our nation greater indebted for its modern armament metallurgy than it is to Col. T. C. Dickson, Commanding Officer of the Watertown Arsenal, who will retire from active military service on September 30 next.

Colonel Dickson's Great Service

In the field of x-ray testing, coldworking, centrifugal casting and the development of welding, the authority of the Ordnance Department of the Army is universally acknowledged. No small part of this record is due to the foresight, good judgment, indomitable energy and leadership of Colonel Dickson. His is a record of great service.

Upon his graduation from the United States Military Academy in 1892, Colonel Dickson served as a second lieutenant of Artillery at Fort Schuyler until 1894 when he began his long service in the Ordnance Department as assistant to the Commanding Officer of the Springfield Armory. Until his promotion to captain in 1901 he filled the important assignments of inspector at the plants of the Colt's Patent Fire Arms Manufacturing Company, American Ordnance Company, Driggs-Seabury Gun and Ammunition Company, Winchester Repeating Arms Company and the Pratt and Whitney Company; he was recorder of the board of Army, Navy and Marine Corps officers to consider the adoption of a uniform caliber for small arms of the three services, and assistant to the Commanding Officer of the Rock Island Arsenal.

As a captain of Ordnance, he served as an assistant to the Chief of Ordnance in Washington, 1902-1906; member and recorder of the board of officers convened in January, 1903, which tested and recommended for adoption the Springfield magazine rifle, Model of 1903, and a member and recorder of the board convened in the same year to test automatic machine guns. From 1903 to 1906 he was recorder of the Board of Ordnance and Fortification. On June 25, 1906, he was promoted to the grade of major. As such he was a member of the Ordnance Board at Sandy Hook Proving Ground. From June 27, 1910 to March 6, 1914, Colonel Dickson was inspector of shops on the Panama Canal under

General Goethals, Chairman and Chief Engineer of the Isthmian Canal Commission. He was Commanding Officer at Sandy Hook and president of the Ordnance Board from April 1914 to August 1915 when he retired under the Act of March 4, 1915. He was returned to active duty at Watertown Arsenal September 15, 1916, and has been continuously in command there since October, 1918. He was promoted to the rank of colonel, Ordnance Dept. N. A., January 10, 1918, and brigadier general the following month.

As well in the esteem of scientists and engineers of metallurgy in civil life as among the officers of the services who have served with Colonel Dickson, his achievements will stand as a monumental contribution to the design and construction of ordnance of the twentieth century. In his retirement from active service he brings to a close a superb achievement to which the efficiency of American armament will long attest.

The Method of Defense is Not Fixed

NOT being an exact science, national defense is one of several inexact others which profit most by free discussion based on sufficient knowledge. To put it another way around, national defense gains definitely when the pros and cons are weighed by an intelligent group whether attendant discussion be in accordance with or the exact contradictory of established policy. The wisdom of this view is as much to be acclaimed today as at any time in the past. Analogies are apparent to everyone who reads of defense subjects in modern as well as ancient times. We have in mind two scholarly analyses which emphasize the point. One appeared a quarter of a century ago; the other only last month.

In his unique book "Fortifications," Sir George Sydenham Clarke twenty-five years ago expressed the above principle with definite reference to fortifications then an important topic. "No science," he said, "is so delightfully empirical as that of fortification. The test of experiment cannot satisfactorily be applied to it; that of practical experience is generally ambiguous. No fad is so unimportant that an instance cannot be found which affects to illustrate its utility; no theory so unpractical that evidence of some sort cannot be produced for its support. For the data are never scientifically complete, and each successful or unsuccessful attack or defense may generally be traced to any one of a dozen causes in accordance with the personal predilections of the writer."

To revert to history, Vauban, great builder of French fortresses of the 17th century, and his method of formal attack had the bastioned trace for its geometrical base. In his day there were opponents of his school who, by imperical processes, arrived at conclusions which were at variance with those of the master builder. But sorties, mines, counter-approaches, and extemporized entrenchments—everything, in fact, which did not come within the cognizance of the draftsman—were ignored by these ingenious theorists!

"Lectures on Field Service Regulations III" (Operations between Mechanized Forces) by Maj. Gen. J. F. C. Fuller, C.B., C.B.E., D.S.O., published last month by Sifton Praed & Co., London, serves to drive home the observation. General Fuller's lectures are on a book which does not exist. The British Army has a confidential text book on operations between mechanized forces but, as he points out, "What is wanted today is a public and not a secret book, a book which may be obtained anywhere, read anywhere and left anywhere, and not a book coupled with lock and key for such books remain under lock and key and are little read except by the curious." It is our purpose to review this important text in an early issue of ARMY ORDNANCE. We refer to it in general terms at this time because it bristles with the doctrine that the minds of thinking men—military and civilian—must be jogged.

From Vauban to Fuller and you have the transition from the static to the kinetic. The French engineer devised the methods of defense adequate to his day; the British general deals with present and future warfare of movement. With the former emplaced protective armor was the need to withstand attack; with the latter the movement of machines in this "transitional military age" is the aim. Both prove conclusively that the method of defense is not fixed and that the application of brain and brawn to all angles of preparedness in the light of current change will assure safety. That means the factory, the forum and the field else the art of defense goes into a rut and wallows there when the next emergency appears.

A Levy on War Profits

IN a communication addressed to the United States Senate, Secretary of the Treasury, Ogden L. Mills, stated his agreement in principle with the recommendations of the War Policies Commission for a war profit tax "designed to bring into the Treasury as far as practicable the entire amount of profits due to war." Logically the Secretary commented that "in view of the fact that the seriousness of the particular war emergency and the circumstances under which it arises can not be foreseen, it does not seem possible to prepare in advance a tax measure which would be suitable for immediate use." "The ideal war income tax," in his judgment, "would bring into the Treasury the entire amount of profits due to the war. There is no reason to doubt that the business men of the country would support a war profits tax properly framed to turn over to the government all actual war profits." The Commission's recommendation that the tax be applied to the excess of income over the average for three pre-war years would seem to be a sound and satisfactory basis for the normal case, which would avoid the serious administration difficulties involved in determinations of invested capital.

In the light of this opinion, the analysis, the studies and recommendations by Colonel O'Shaughnessy in respect of war contracts which are published in this issue of ARMY ORDNANCE are of timely significance because that analysis discloses the scrapping of the "cost plus" form of contract. Thus most of the inordinate gains and many of the excesses of our World War experience are automatically scotched. It was little enough to expect that sane judgment would be applied in the study of this irksome question of war profits and the methods adopted indicate quite clearly that efficient munitions manufacture in time of war can be carried on insofar as the economic and legal aspects of contracts are concerned with dispatch, a maximum of fairness to the contractor and a minimum of opportunity for unconscionable profits.

Should the provisions of the new war contract become a standard of procedure in an emergency, the excess profits tax will not furnish the Treasury with an extensive source of revenue. The cure for an ailment which at times during the

World War was an epidemic of disease will have been applied even more effectively than by a tax. No group will welcome with greater enthusiasm all just provisions for the elimination of excess war profits than those American individuals and companies who will produce the implements of defense in the event of war. They, better than anyone else, realize from past experience that temporary profits of an excessive nature are not always compensatory for the many disadvantages which war production involves.

Ordnance Reserve Training in Demand

FOUR hundred and one applications were received for training in the summer courses for Ordnance Reserve Officers which are now in progress at various posts and stations. Due to the limitation on training funds it was necessary to disapprove 135 with the result that 266 reserve officers are being trained this summer. In selecting those who were fortunate enough to go to camp the Department is following a regulation which allows training for supply officers once in every five years and for officers with combat assignments once in every three years. It is apparent that these restrictions seriously impede the value of the whole training scheme and it is ardently hoped that some way of providing more frequent training with the limited funds available can be found.

This year summer training courses were or will be conducted at Frankford, Picatinny, Raritan, Rock Island and Watertown Arsenals, Springfield Armory, Aberdeen Proving Ground and at the University of Michigan and at Massachusetts Institute of Technology. Both the general and advance training courses were conducted at Rock Island and Aberdeen while officers with combat assignments received training with field organizations at various stations throughout the country. All in all, we feel that the Department has done splendidly in apportioning its reduced resources so that they will accomplish the best results and we are confident that many reserve officers who were unsuccessful in obtaining training this year will agree that a difficult situation was well handled.

Abolitionists in a New Role

THE American delegation of statesmen and experts who are returning from the disarmament conference at Geneva may explain later the intricacies of their policy of abolition. Thus far the record reads mystifyingly strange. Just prior to the concluding session of the conference the deadlock with reference to matters of munitions revealed our altruistic attitude in this respect.

As to tanks, the French delegates at first wanted them limited to seventy tons, later they were willing to accept a limitation of twenty-five tons, the British came down from twenty-five to sixteen. Our delegates insisted on the abolition of tanks.

As to aviation, the French wanted to retain the right to bomb battle zones. The British were for that and another zone outside the battle area. Our delegation was for abolition. The artillery difficulty, according to the *New York Times,* was "caused by the American desire for a low level for mobile guns, excluding coast defenses, and the French opposition to a distinction between fixed and mobile guns and a desire for bigger mobile guns if they are retained."

With our own spokesmen set on abolition there is all the more reason to add hearty approval to the comment of the *Army, Navy and Air Force Gazette* (London), "After all this talk, how far have we got? From proposals for the complete abolition of armaments we have now reached the stage when the main subject at issue seems to be whether any one particular form of armament is or is not aggressive and should or should not be abolished. Surely politicians are not as competent to discuss technicalities of this sort as the heads of the various fighting services. It is safe to predict that they can here reach no finality, and that finality, even if it were reached, would mean nothing in practical results. A nation will always attempt to spring a surprise on an enemy by producing new and devastating weapons, the secret of the existence of which has been carefully guarded. History furnishes numerous examples, such as the French machine gun in 1870, and gas and the tank in the Great War. Legislation cannot prevent the use of weapons of which the existence is not known. In the meantime the real issue seems to have been completely obscured by these academic discussions of technical detail. What difference would it make, for instance, how much a man would eat if you restricted the number of knives and forks at his table and what real difference would it make if you established that his fork was an offensive and his knife a defensive weapon? Yet it is with similar suggestions applied to armaments that the disarmament conference continues to mystify itself and amuse the world. To curtail the amount of food a man will eat, you must deaden his appetite and so it must be with war." Since our attitude seems to be one of doing away with the knives and forks altogether, it presumably follows that no one will eat. One would think our experience with the abolition of drink had proved the point.

Government Competition with Business

SOME interesting reactions may be expected from the deliberations and recommendations of a committee authorized at the recent session of Congress to investigate government competition with private enterprise. Hon. Joseph B. Shannon of Kansas City, Mo., is chairman of the committee. It began its hearings two weeks before the adjournment of Congress. The committee intends to hold hearings in various parts of the country until the Congress convenes in December.

How far the committee has progressed to date may be gathered from the following observation by the *Independence (Kansas) Reporter* referring to the appearance of merchants of Leavenworth who laid their complaints before the committee at a hearing in that locality: "Army canteens were originated to provide soldiers with necessities which they could not conveniently purchase at civilian stores. Today, with most army posts located several miles from retail centers, their service is needed. However, the Leavenworth men show the power of the canteen to buy at wholesale is abused by its making purchases of articles which rightfully should be made through regular channels of trade. In this way the government enters into unfair competition with its citizens."

The inquirers would do well to leave the necessaries of army life alone and turn their attention to other activities of government which really compete with business.

The National Defense Act - It Must Be Preserved

An Editorial

THE ides of July 1932 presented a sorry spectacle: the Army of the United States was technically broke. The bill making appropriations for our military defense after being unnecessarily delayed in its presentation to Congress was maliciously deadlocked by a few legislators who proposed to transfer two thousand officers to the retired status. Good judgment and good leadership combined with parliamentary maneuver finally won out and the reduced appropriations were provided fourteen days after the beginning of the present fiscal year.

Few will take exception in these days to the drastic reduction in the amount of the appropriations for the Army. The total for the military activities of the War Department for the fiscal year 1933 is $290,575,924.00 as against $340,324,517.32 for 1932, a reduction of nearly $50,000,000 under last year. The regular officer strength is not molested and while certain activities are curtailed and active and retired pay and allowances are reduced by the Economy Bill, the major effect is in line with the temporary tightening of belts everywhere and in every walk of life. Carrying-on with reduced rations is not new to the Army. It will not whimper at payless furloughs and delayed projects—it will be the last of our national groups to not play the game according to depression rules.

BUT, now that the assault has been parried, wise counselors will assemble the mass of detail incident to the recent legislative battle and endeavor to interpret the situation in its cause and effect. Interested observers will seek to discover trends, if there are any, and urge correctives. Devotees who deny that there is a very definite and apparent trend are closing their eyes to the obvious. Enthusiasts who see no need for correctives are soundly asleep. The real corrective is not in or of the Army. It is none other than the need for old-fashioned, homespun remedies that have been and are the tonic of a sovereign nation. Levelheaded preparedness on our own responsibility with less thought and attention to qualitative disarmament and similar shibboleths; ample protection for our far-flung territory; adequate forces to preserve our rights and maintain our peace; strict attention to our own household and less to the unwilling menage of others. These are the first corrective approach to sound national defense doctrine. On the other hand, the trend, of small but growing proportions within our own gates, is an implied and in some quarters an open movement toward the disintegration and even the crucifixion of the National Defense Act. This trend, apparent in the sorry spectacle to which we have referred, is plainly evident in the unsuccessful though none-the-less crafty effort to gibbet the organic law upon which our military defense is built. It is a situation of grave concern. It demands plain talk and firm resolution by friends of national defense and by their friends and by friends of their friends.

It would be silly to say that this conclusion is a veiled plea of parties in interest to assure jobs to a few regular officers of the Army or that it is a hidden shudder at the jeopardy of active duty pay of the National Guard or the Organized Reserves. In the long run these are only the means of the attack and not the end of it. The candid student will approach the situation far more openly and above board than such a basis suggests. Fault will not be found, for example, with the fair critic who claims that delay in pushing uncompleted defense projects to completion is secondary to a sound national financial structure and therefore that these plans bide their time until taxation is less burdensome. In other words, the sincere analyst of national defense who sees room for improvement in this or that detail is to be praised for his interest and not condemned because he differs from majority opinion. Indeed national defense will be the better for his pains.

GRANTING all this, the fact remains that a slipshod or political-football attitude toward the National Defense Act is unwarranted, unfair and decidedly dangerous. In its fundamentals the Act is the most definite and sensible scheme in our entire history for adequate national security. Never before have we had the sound foundation it provides. To its sane provisions can be attributed the most comprehensive plan and fool-proof method of preparedness our country has ever experienced. When we are ready to substitute machines for men in war it will be through administration of the Act and not in abrogation of it. When we are sure that we are immune from unfriendly influence and that our interests at home and abroad are secure the Act will permit of appropriate modifications. When we are willing to grant that international conferences will settle differences for all time and that a smaller and less efficiently equipped police force is sufficient for internal and external protection the Act will still assure maximum efficiency of that force. Not many people are prepared to say that any of these contingencies are *fait accompli*. Until they are, if ever they are, the National Defense Act, embodying as it does the experience and pitfalls of more than 150 years, must stand untampered.

Friends of national defense would do well to recall an incident of other days when in the pinch of hard times many minds turned to phantom facts. Then no less a doctrine than the very foundation of our Constitution itself was at stake. Rugged leadership girded for battle and won under the rallying cry "Our Federal Constitution it must be preserved." Today for us the slogan needs only the substitution of the National Defense Act. The Act stands for an adequate Army, efficiently trained, competently manned, properly equipped, economically operated. It assures manpower and munitions power as they have not been assured before. It guarantees a small standing army and a large trained civilian component. It makes industrial preparedness the keystone of munitions development and supply in peace and war. Such a law cannot be allowed to give an inch to political or pacifistic attack; it cannot be permitted to sag at all under personal pique and not too much under economic necessity. Trends that veer toward sapping its sinews under the guise of efficiency or economy but which in reality are the bold tactics of ward politicians are bad signs. They challenge our belief which rests on the sure foundation of bitter experience. They defy the lessons of preparedness with which many of us who have learned in full measure will tolerate no compromise. There is but one course for adequate security: the National Defense Act—it must be preserved!

Association Affairs

Postponement of the Aberdeen Meeting of the Association

THE Officers and Directors of the Army Ordnance Association announce that the annual meeting of the Association will not be held this year in Washington and at the Aberdeen Proving Ground on October 5th and 6th, as previously published. Present conditions and the necessity for economy, in the opinion of the Board, make this action advisable from the expense viewpoints of all concerned. The postponement of the Washington and Aberdeen sessions is for the current year only and it is the expectation of the officials of the Association that conditions will warrant holding the meeting in Washington and at the Proving Ground in 1933 as heretofore.

It is regretted that conditions make this change necessary. The splendid coöperation of officials of the War Department in past years and their helpful consideration of the recommendation by the Association that the demonstrations be postponed this year together with their assurance that the Aberdeen meeting be held in 1933 bespeak the value to the national defense which is officially placed upon these gatherings. This and the concurrence of the several national organizations already invited to participate in the sessions planned for October are much appreciated. Under the circumstances it is hoped that all members will likewise concur in the advisability of the action of the Association's officials.

It is proposed to hold the annual meeting of the Association in conjunction with the New York Post later in the year, due announcement of which will be published in this Journal.

Biennial Election of Officers

IN accordance with the provisions of the Constitution and By-Laws of the Army Ordnance Association, the biennial election of officers and directors will be held Tuesday, September 6, 1932. The election will be by letter ballot. Ballots were mailed July 30th to all members who are entitled to vote.

The nominees selected by the Committee on Nominations for terms of office beginning January 1, 1933, are: For President, to serve two years: Brig. Gen. Benedict Crowell, Cleveland, Ohio; for Vice-Presidents, to serve two years: Col. William W. Coleman, Milwaukee, Wis., and Col. William C. Spruance, Wilmington, Del.; for Directors, to serve four years: Col. Frank A. Scott, Cleveland, Ohio; Col. Robert P. Lamont, Washington, D. C.; and Col. Charles L. Harrison, Cincinnati, Ohio.

The Committee on Nominations appointed by the President pursuant to Section 20 of the By-Laws consisted of Maj. Gen. C. C. Williams, former Chief of Ordnance, U. S. Army, Chairman; D. C. Jackling, Director, California Post; E. J. Buffington, Director, Chicago Post; Theodore Swann, President, Birmingham Post; and J. Rogers Flannery, former Director, Pittsburgh Post.

Boston Post

THE annual meeting of the Boston Post, Army Ordnance Association, was held June 3, 1932. After the approval of routine reports of the Secretary and Treasurer, Col. Edward I. Miller, at the request of the President, presided for the election of officers. The following were elected: President: Lt. Col. R. F. Whitelegg; Vice-President: Lt. Col. James S. Smyser; Directors (to serve two years) Messrs. Everett Morss and Charles E. Cowdrey and Maj. Clark S. Robinson; and Director (to serve one year to complete his own unexpired term) Capt. R. J. Thanisch.

Lieut Col. Charles G. Mettler, Executive Officer of the New York Ordnance District, was the principal speaker of the evening. His topic was "Our Armament Situation." This interesting address was received with a great deal of enthusiasm by all members of the Post who were present.

Annual Meeting of Bridgeport Ordnance District

THE Eighth Annual Meeting of the Bridgeport Ordnance District was held at the Hotel Bond, Hartford, Conn., the evening of Wednesday, June 8th. The meeting was attended by 170 manufacturers, reserve officers and guests. Among the honor guests were: Hon. Frederick H. Payne, The Assistant Secretary of War; Brig. Gen. W. H. Tschappat, Assistant to the Chief of Ordnance, U. S. Army; Col. Walter S. Grant, Chief of Staff, First Corps Area; Col. J. W. Joyes, Commanding Officer, Springfield Armory, and Lt. Col. Earl McFarland, Executive Officer to the Assistant Secretary of War.

Among the manufacturers from the district present were: Mr. C. R. Burt, President, Pratt & Whitney Company, Hartford; Mr. John H. Goss, Vice-Pres., Scovill Mfg. Co., Waterbury; Mr. E. Kent Hubbard, President, Manufacturers Association of Conn., Hartford; Mr. Edwin Pugsley, Factory Superintendent, Winchester Repeating Arms Co., New Haven; Mr. S. M. Stone, President, Colt's Patent Fire Arms Mfg. Co., Hartford; Mr. W. R. Webster, Chairman of the Board, Bridgeport Brass Company, Bridgeport; Mr. A. B. Reynders, Works Manager, Westinghouse Electric & Mfg. Co., Springfield, all members of the District Advisory Board; Mr. H. H. Pease, President, New Britain Machine Co., New Britain, Conn.; Col. J. B. Schoeffel, Chief of Staff, 76th Division, Hartford; Mr. W. H. Bassett, Metallurgical Manager, The American Brass Co., Waterbury, and Chairman of the District Metallurgical Advisory Committee. A total of 80 reserve officers assigned to the Bridgeport District were present.

The District Chief, Col. B. A. Franklin, presided at the meeting and introduced as the principal speakers of the evening Colonel Payne, General Tschappat and Colonel Grant.

Colonel Payne, formerly Assistant Chief of the Bridgeport District, spoke of the efforts now being made by pacifists and others to weaken the national defense and particularly of the reduced appropriation carried in the pending Army Appropriation Bill, for the maintenance of the Regular Army, Organized Reserves, the Reserve Officers Training Corps, and the Citizens Military Training Camps. He pointed out that this movement to materially reduce the strength of the Army and to restrict training activities was due in part to the fact that many of our influential citizens have not seriously considered the subject and that when the facts are brought forcefully to their attention many of them are awakened to a realization of the importance of maintaining adequate national defense.

General Tschappat spoke of the outstanding importance of the Bridgeport District in the supply of small arms ammunition, non-ferrous components of artillery ammunition and of inspection gages and machinery. He stated that the great interest that

the manufacturers of this district have shown in industrial preparedness and their coöperation in the procurement planning activities of the Ordnance Department would be of tremendous value in the event of an emergency.

Colonel Grant gave a very interesting account of the staff work in planning for the artillery for the Saint-Mihiel Drive during the World War. He also spoke of the General Staff studies following the World War regarding the problem of disposing of the surplus war supplies. He showed how these studies resulted in the preparation of the General Mobilization Plan.

Membership Committee

THE Committee on Membership, Lieut. Col. LeRoy Hodges, Chairman, makes grateful acknowledgment of the coöperation of many members of the Association in the efforts of the Committee to obtain new members. Special thanks are tendered by the Committee to Mr. Theodore E. Moritz, an official of American Steel Foundries, Chicago, who, during the past three months has obtained thirty-eight new members. Mr. Moritz is a charter member of the Association. His record in nominating this large number of new members among his business associates is typical of his energetic and successful accomplishment for the organization in many ways during past years. The Committee has presented to Mr. Moritz the gold lapel emblem of the Association which is awarded to members who obtain five new members. For his exceptionally fine assistance he has also been awarded by the Committee the medal of the Association in gold as a further token of congratulation and thanks.

The gold lapel emblem also has been presented by the Committee to Mr. Newton I. Steers, President of the duPont-Pathé Film Manufacturing Corporation, New York City, who procured six new members.

The New Cover Design

FOR the past three and a half years ARMY ORDNANCE has been featuring as its front cover a series of etchings by Joseph Pennell and Vernon Howe Bailey. These have been repeated several times and notwithstanding their beauty and artistic merit the Editors fear that the repetition may become somewhat monotonous. Hence the departure, for the time being at least, and the new modern design which makes its appearance with this issue. The new cover incorporates the seal of the Association and utilizes the traditional Ordnance colors, crimson, yellow and black. It has the added convenience that the titles of leading articles are at once evident.

In addition there is the not-to-be-overlooked advantage of expense. In these days of necessity the economical advantage is material and effort has been made to combine these considerations as attractively as possible. Expressions of opinion from readers are invited. If the predominant feeling is that the continued repetition of the Pennell and Bailey etchings is more pleasing, the majority will rule.

Obituary

MR. ROBERT SCOTT LOVETT, Chairman of the Board of Directors of the Union Pacific Railroad and Chief of the Priorities Division of the War Industries Board during the World War, died at his home in Locust Valley, L. I., N. Y., June 19, 1932. He had been a member of the Army Ordnance Association for many years.

Long identified with the late Edward H. Harriman and former head of the Harrington railroad interests, Mr. Lovett was born at San Jacinto, Texas, June 22, 1860. He was admitted to the bar in 1882 and soon became one of the leading railroad lawyers of his native state.

In August, 1917, Mr. Lovett was called to Washington as a member of the War Industries Board. He was placed in charge of the Priorities Division and participated in all the important activities of that branch. When the Government took over the railroads in January, 1918, Mr. Lovett became director of the division of capital expenditures of the Railroad Administration. He continued at this latter post until after the signing of the Armistice when he resigned and returned to his former position with the Union Pacific Railroad from which he had resigned before entering war work. He was president of the railroad until March 1, 1920, and had been chairman of the board since then.

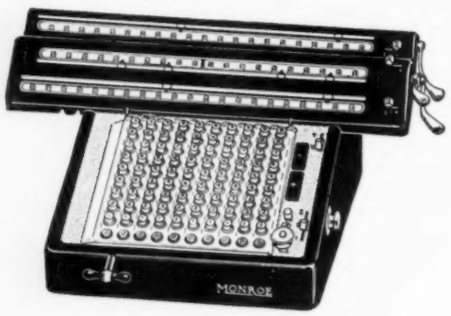
Necrology

SINCE publication of the last issue of ARMY ORDNANCE notice has been received of the death of the following members of the Association: Thomas S. Gassner, Philadelphia, Pa.; Alfred H. Mulliken, New Canaan, Conn.; L. A. Russell, Milwaukee, Wis.; Cameron C. Smith, Dunkirk, N. Y., and Henry J. Wiegand, Okauchee, Wis. To the relatives and friends of these deceased members the Association extends condolences.

New Members

THE following have been admitted to membership in the Army Ordnance Association since the last issue of ARMY ORDNANCE: Charles C. Bacon, Philadelphia, Pa.; Geoffrey H. Baxter, Berkeley, Calif.; M. R. Beatty, Hammond, Ind.; Wallace Benedict, New York, N. Y.; Leo A. Berti, San Francisco, Calif.; Joseph L. Block, Chicago, Ill.; Eugene W. Bowls, Berkeley, Calif.; O. H. Briggs, New York, N. Y.; J. D. Burke, Detroit, Mich.; Philip E. Calo, Chicago, Ill.; Joseph B. Card, Chicago, Ill.; Gordon W. Chambers, Philadelphia, Pa.; E. J. Clancy, Cleveland, Ohio; H. Cohen, St. Louis, Mo.; James F. Collins, Chicago, Ill.; Melvin R. Comer, West Orange, N. J.; Julian S. Deane, Springfield, Mass.; John Dillon, Keokuk, Iowa; J. F. Donahue, Cleveland, Ohio; Charles Dreifus, Pittsburgh, Pa.; Cyrus G. Dunkle, Dover, N. J.; H. G. Elfborg, Chicago, Ill.; Jay Gaines, Bay Village, Ohio; E. H. Gates, New York, N. Y.; William Goldsmith, Canton, Ohio; P. P-G. Hall, Philadelphia, Pa.; Albert Hancock, Chicago, Ill.; Thomas J. Harrigan, Chicago, Ill.; Robert E. W. Harrison, Mt. Washington, Ohio; Joseph E. Jacobson, Pittsburgh, Pa.; W. T. Kilborn, Chicago, Ill.; D. H. Kinloch, Parlin, N. J.; F. O. E. Knudson, West New Brighton, S. I., N. Y.; Robert B. Ladd, Lewiston, N. Y.; Paul B. Lavery, Poughkeepsie, N. Y.; Harry S. Lewis, Chicago, Ill.; J. R. Linney, Lyon Mountain, N. Y.; W. S. Lister, Cleveland, Ohio; Robert M. Loeb, Rochester, N. Y.; Ernest N. May, Wilmington, Del.; Henry D. Miles, Buffalo, N. Y.; Preston S. Millar, New York, N. Y.; Harry W. Mons, Chicago, Ill.; C. B. Pollock, Brackenridge, Pa.; John M. Price, New York, N. Y.; Harry Publicker, Philadelphia, Pa.; Charles L. Reasoner, Berkeley, Calif.; Earl C. Robertson, Pittsburgh, Pa.; A. J. Roos, Canton, Ohio; Frank C. Rutz, Rockford, Ill.; G. A. Scanlan, New York, N. Y.; Horatio S. Schroeder, Chicago, Ill.; V. B. Sease, Parlin, N. J.; Paul M. Seleen, Aberdeen Proving Ground, Md.; F. K. Serkland, San Francisco, Calif.; DeWitt C. Showers, Chicago, Ill.; Frank J. Smith, Rochester, N. Y.; J. Wesley Smith, Santa Monica, Calif.; Max Solomon, Pittsburgh, Pa.; Harry E. Spires, Richmond, Calif.; A. B. Steffens, Chicago, Ill.; David Strauss, New York, N. Y.; Kenneth G. Sturtevant, Rock Island, Ill.; Edward K. Tryon, 3rd, Haverford, Pa.; George E. Viereck, Columbus, Ohio; Seymour Wheeler, Chicago, Ill.; Ben P. Williams, St. Louis, Mo.; Parker H. Woods, St. Louis, Mo.; Alexander H. Woollen, New Kensington, Pa.; and H. W. Young, York, Pa.

The Index to ARMY ORDNANCE, Volume XII, is now available for distribution. It is arranged by subject and author alphabetically and includes title page for binding. Copies of the Index will be furnished without cost upon application to the Editorial Office.



The New Noiseless
MONROE
ADDING-CALCULATOR

NEW accumulator dials—positive or negative, new keyboard construction, new clearance and shift, new half-cent and split dials, are features that save countless, costly operations in figuring.

MONROE CALCULATING MACHINE COMPANY, INC.
ORANGE, NEW JERSEY
Offices in all principal cities

SPERRY

Manufacturers of

Searchlights
Sound Locators
Gyro-Compasses
Gyro-Pilots
Ship Stabilizers
Gun Control Equipment
Recording Theodolites

Special mechanical and electrical equipment of a precision character

SPERRY GYROSCOPE CO., Inc.
BROOKLYN, NEW YORK

AOA

Communications

Forcing Resistance of Bullets As Related to Velocity

THE EDITOR:

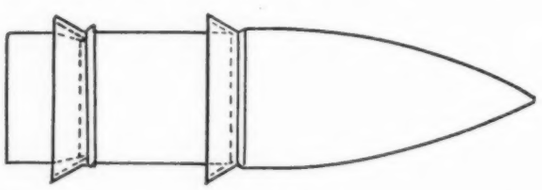
An article by Cranz and Schardin in *Zeitschrift fur technische Physik*, No. 3, 1932, describes a method for determination of the amount of force required to overcome the resistance due to friction and to displacement of metal of a projectile in its passage through a gun barrel.

According to the description in the article referred to, experiments were made with a gun of a 7.9-mm. caliber and a standard German 10-gram bullet. A powder charge of two grams was used. A resistance curve (pressure vs. time) shows maximum pressures in the order of 200 kilograms for forcing resistance with maximum powder pressures from 330 to 380 kilograms. It is apparent that the forcing resistance is of some importance.

This conclusion is partially verified by limited experience on bullets having reduced bearing surface. Bullets with reduced bearing surface have shown an increase in velocity of approximately 150 f. s. with the same powder charge. In these experiments the bullets having a reduced bearing surface weighed slightly more than those with the regular bearing. The recovered bullets showed evidence of slipping, which indicates that the problem of producing a bullet in which the frictional resistance shall be reduced is not as simple and easy as one might think.

The article by Captain Green in the May-June, 1932, issue of ARMY ORDNANCE, shows projectiles patented many years ago in the design of which it appears possible that some thought was taken of the effect of reduction in resistance. However, these bullets were not of the jacketed type and it is now known that lead bullets will expand or swage practically the full bore diameter from the base to the beginning of the ogive with any standard powder charge. This leads to the conclusion that only a jacketed bullet can be made with reduced bearing.

If in addition to the reduction in frictional resistance the escape of gas along the rifling grooves could also be prevented, it would be possible to obtain standard velocity with standard weight projectiles with much reduced powder charges; or, on the other hand, much higher velocities could be obtained with standard powder charges and standard weight bullets. A bullet shape which provides for both reduction in forcing resistance and possibly escape of powder gases is shown in the accompanying sketch. Of course, such a shape is not really new, as two rotating bands which in effect are shown were used on cannon projectiles, particularly with the German type, for many years.



Washington, D. C., July 5, 1932. J. C. GRAY.

The Ordnance Job at Mehun-sur-Yevre

THE EDITOR:

With reference to Major Bull's comment (published in the May-June, 1932, issue of ARMY ORDNANCE) on my article

"Unknown Soldiers" which appeared in the March-April issue, I have no apology to make for what Major Bull apparently thinks is an exaggeration on my part.

When I said that we were ready at the Ordnance Depot at Mehun-sur-Yevre to supply ingot metal to the French I meant just that. I do not remember that Major Bull ever attended the "Whispering Club" which was a sort of council of war held every night in the officers' mess hall. If he had he would have known that we could have shipped ingot metal within a week or ten days after receipt of the order.

As a case in point, when skin diseases broke out in the camp and the medical inspector ordered that the washing of clothes in the canal be discontinued, it took one session of argument to convince us all that while Army Regulations charged the Quartermaster Department with the operation of laundries it did not forbid the operation by the Ordnance Department. The very next day I had the officer in charge of stores telephone everywhere possible in France and locate equipment for a laundry. It is still too near the war to tell just how we obtained it, but we had a laundry set-up and washing the clothes of more than 5,000 men within a week. (Nobody steals anything in emergency; they "salvage" it.)

Needless to say, we could have had oil-operated melting furnaces set up at Mehun within a week. In regard to the 300 wrenches actually made before the Armistice, they were all made from orders which I approved and a high point in production would have been reached within a few weeks if the war had gone on. We were just beginning to receive large carload ship-

Salvaged Shell and Cartridge Cases at Mehun.

ments of salvage from the front at the time of the Armistice, and I have photographs of mountains of shell and cartridge cases unloaded back of the Mehun foundry.

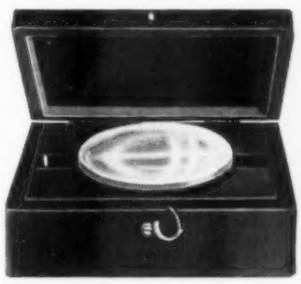
I certainly have respect for Major Bull's ability as a foundryman, but I am afraid that he takes the conservative civilian attitude toward these problems. Anyone who has dealt with officers like Colonel Wesson, who was in charge at Mehun during the clean-up period, knows that he could not long remain if he began to raise objections to what could be accomplished. In September, 1918, the French gave us many arguments as to why it was not possible for us to make 75-mm. gun parts at Mehun, but I happened to have been on the Commission that took over the work, and I know that our men delighted in picking out the hardest jobs and then proving that they could do them. I saw this same spirit at work during the construction days on the Panama Canal under Colonel Goethals. The wonder of it all was that the very small group of regular Army officers during the War had the ability to inspire this spirit into the great group of temporary officers.

GEORGE S. BRADY,
Lieut. Col., Ord. Res., U. S. Army.

New Rochelle, N. Y.

OPTICAL TEST PLANES

FOR CHECKING
ACCURATE PLANE SURFACES



M 405-406h

Made of hard glass (plane or Pyrex), polished on both sides, in two sizes: 65mm and 130mm. Fully described in Catalog M-130, sent on request.

OTHER SPECIALTIES

Glass or Stainless Steel Mirrors — Interferometer Plates — Achromatic Objectives — Glass or Quartz Lenses, Prisms — Rock Salt Prisms — Roof Prisms.

Special Optical Parts Made to Order

The GAERTNER SCIENTIFIC CORP.
1201 Wrightwood Ave. Chicago, U.S.A.

J&L STEEL

J&L STEEL PRODUCTS
(OPEN HEARTH AND BESSEMER STEEL)

HOT ROLLED BARS, PLATES AND SHAPES
LIGHT WEIGHT STAIR STRINGER CHANNELS
RAILROAD SPIKES TIE PLATES
Light Rails and Accessories
BARS FOR CONCRETE REINFORCEMENT
FORGING STEEL
JALCASE STEEL
COLD FINISHED STEEL
JUNIOR BEAMS
STEEL PILING
FABRICATED STRUCTURAL WORK
TUBULAR PRODUCTS
Welded and Seamless
WIRE PRODUCTS
TIN MILL PRODUCTS
COKE BY-PRODUCTS

JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
PITTSBURGH, PA.

GULF

ONE CLEAR FACT

. . . Out of a tangle of claims about gasoline . . . one clear fact stands out . . .

That Good Gulf Gasoline

is bought more places by more people in Gulf's 27 states because car owners buy on performance . . . the only fact that counts.

GULF REFINING CO.

INTERLAKE IRON CORPORATION

Manufacturers of

Pig Iron

Foundry — Malleable — Basic

and

Coke

For Foundry and Domestic Use

Chicago Office

R. 1500 McCormick Building

Design of the Gun-Howitzer Carriage, T2

THE EDITOR:

Upon reading the article, "Building a Great Weapon in Record Time" published in the May-June, 1932, issue of ARMY ORDNANCE, the writer fears that he may have created the impression that the Rock Island Arsenal is entirely responsible for the design as well as the manufacture of the 155-mm. Gun—8-inch Howitzer Carriage T2. It will be appreciated if ARMY ORDNANCE will publish this letter so that the design engineers of the Office of the Chief of Ordnance may receive just and due credit for their part in what is believed to be an exceptionally good design.

As a matter of record, it is understood that the design of this carriage was worked on for a period of more than a year before Mr. T. A. Conlon of the Artillery Division, Office of the Chief of Ordnance, on August 13, 1930, arrived at the Rock Island Arsenal with 128 vellums for the design, of which 43 were studies in assembly views and 85 were studies in details. A number of the Arsenal draftsmen were turned over to Mr. Conlon for his supervision and these men under his direction worked-up 733 additional drawings. Of these 597 were detailed drawings; 48 were layouts; 54 were assemblies; 2 were lists of drawings; 4 were lists of equipment, and 28 were lists of parts. The fact that the design was completed in the remarkably short time of 81 working days was in no small part due to the early studies.

J. W. SLATTERY,
Rock Island, Ill. *Capt., Ord. Dept., U. S. Army.*

Ordnance Service

THE EDITOR:

I regret exceedingly that I have been unable to have ready for publication in your July-August issue, another article on "Ordnance Service." In the absence of such an article, I wish to reply to the published comments on my first article.

I have a great deal of fault to find with the English language as a medium for conveying an idea. In this case it is with the word "sell." I cannot conceive of a modern commander in time of war who will be able to go shopping for his ordnance. No high pressure salesmanship is required here. But, when he begins "crabbing" about the inadequacy of what he is getting, true enough, it becomes necessary to "sell" him the inadequate article as *the* one which meets all his needs,—if that can be called "selling." Consequently, I see nothing contradictory in the statements: "There will be no need to sell Ordnance supplies in war time" and . . ."discovering how the Ordnance supplies already on hand in the theater of operations . . . can be successfully employed under the special conditions. . . ."

I cannot get excited over a difference of opinion about ordnance methods in the theater of operations. It matters little which one is selected now, except that it be based on existing staff instruction at general service schools, and be accepted as doctrine by all Ordnance officers. Then everybody will get off on the same foot. If they stay in step for the first thirty days in the theater of operations, the prescribing of the method will have served its purpose. By that time the people in the theater of operations will have developed their own methods.

It is possible, however, to deduce principles worth studying, which will act as a guide to the formulation of new methods. There can be no argument about the principles that the supply system should be flexible; that "bulk stocks" and "balanced stocks" should be independently stored; that prior to any requisition supplies in the communications zone must be packed for shipment to the combat zone; or that complete rounds of ammunition must be stored together on the same rail or road route through a "balanced stock" ammunition depot. Only the methods of applying these invites difference of opinion. I hope to be more specific in my suggestions in subsequent articles.

H. S. AURAND,
Washington, D. C. *Major, Ord. Dept., U. S. Army.*

AOA

Professional Notes

Firepower of the Infantry

ACCORDING to the semiannual report of progress in development by the Chief of Infantry, several noteworthy advancements in firepower are under way. The report emphasizes that study and experimentation in the field of Infantry reorganization have been directed primarily to the development within the Infantry battalion of increased firepower without a decrease in flexibility and mobility. As a means to this end the adoption of a light machine gun as an organic weapon in the rifle company is considered essential. Pending the development of a more suitable weapon of this type, much experimental work has been done with the Browning automatic rifle equipped with a bipod, and the air-cooled, Browning, caliber .30 machine gun (tank machine gun) equipped with a special mount for ground use. Seventy-two of the latter have been issued to certain Infantry units for a practical test with special reference to their mobility when manhandled by the elements of the assault echelon of the rifle company.

The service test which was made throughout the Infantry of Training Regulations 300-5 has been followed by a revision of the text. This revision will be published in the near future as a part of Basic Field Manual, Volume III. The text provides a satisfactory course of training for use of the rifle and automatic rifle in defense against the attack of low-flying aircraft.

However, adequate means and methods of training machine gun antiaircraft marksmanship have not been provided, largely because of the fact that suitable equipment for this type of firing has not been developed. The Infantry machine gun is primarily a ground target weapon and the standard mount does not permit of effective use of the gun against airplanes. For such use the gun must be so mounted as to permit of a free traverse of 360° and a free elevation of 90°. Various adapters have been devised and tested by the Infantry Board, but none has proved entirely satisfactory. Excessive vibration of the gun when mounted on the adapter and the uncomfortable position that the gunner must assume in operating the weapon—neither of which is conducive of accuracy—are the principal unsatisfactory features encountered in the employment of the machine gun as an antiaircraft weapon. Sixty T4E2 type adapters produced by the Ordnance Department were sent out in April, 1931, for service tests by twenty-seven Infantry organizations and reports of these tests are now in the hands of the Infantry Board. These reports indicate that this adapter will serve fairly well until something better is produced.

Another solution of this problem is being sought through the development of a cradle for the machine gun tripod which will provide for both ground and antiaircraft firing. Such a device will be more stable than any adapter. Two model cradles have been constructed, one by the Ordnance Department and one by an Infantry officer at Fort Benning, Georgia. Both models have given promising results in preliminary tests. Recommendations will be made that a regular test be given both these cradles as soon as they become available.

Due to limitations of terrain and ammunition allowances, efforts have been made during the past several years to develop a caliber .22 mechanism for the Browning, caliber .30 machine gun, Model 1917. The development of such a mechanism would not only improve training in machine gun marksmanship for the Regular Army, with no increase in funds for ammunition, but

CLE-FORGE HIGH SPEED DRILLS
TRADE MARK REG. U.S. PAT. OFF.

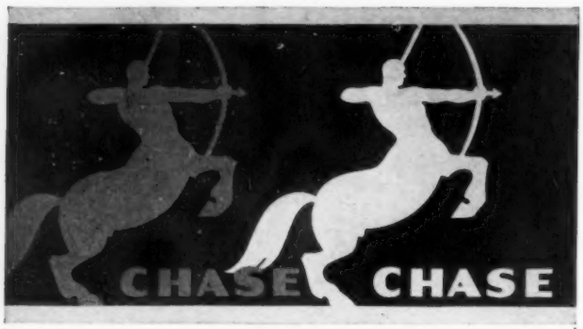
TRADE MARK REG. U.S. PAT. OFF.

Since 1924, Cle-Forge High Speed Drills have held the world's records for drilling through cast iron, machinery steel and chrome nickel. Why not send for "Speed and Feed Tests" and Performance Data?

The CLEVELAND TWIST DRILL COMPANY
CLEVELAND
NEW YORK-CHICAGO-LONDON
SAN FRANCISCO
TRADE MARK REG. U. S. PAT. OFF. AND FOREIGN COUNTRIES

Carbon and Alloy Steels
Toncan Copper Molybdenum Iron
Enduro Stainless Irons
Pipe and Tubular Products
Toncan Iron Pipe
Electric Weld Pipe
Bars and Shapes
Hot and Cold Rolled Strip, Plates
Black and Blue Annealed Sheets
Galvanized Sheets
Special Finish Sheets
Galvannealed Sheets
Electrical Sheets
Tin Plate
Nuts, Bolts, Rivets, etc.
Die-Rolled Products
Coke, Pig Iron

REPUBLIC STEEL CORP.
General Offices, Youngstown, O.



Brass and Copper

Immediate delivery from

19 Convenient Warehouses

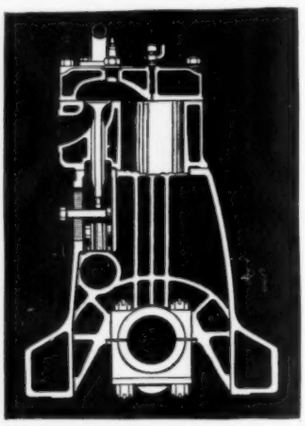
Chase Brass & Copper Co.

Incorporated

Waterbury Connecticut

New York, Boston, Buffalo, Newark, Philadelphia, Baltimore, Pittsburgh, Cincinnati, Cleveland, Detroit, Chicago, Minneapolis, Milwaukee, St. Louis, New Orleans, Los Angeles, San Francisco, Oakland, Seattle.

STRONG AND DEEP



"Girder" Crankcase

Waukesha's "girder" type crankcase is designed for extra rigidity, both in bending and in torsion. The steel backed bearing caps are held by four heat-treated alloy steel stud bolts. Reciprocating parts are closely paired and accurately balanced. Not only is objectional vibration thus eliminated but the combining of "girder" crankcase, rigid bearing and crankshaft construction is an exclusive Waukesha feature that makes double flywheels or dampeners unnecessary.

WAUKESHA ENGINES

WAUKESHA WISCONSIN

would greatly facilitate and improve training in the National Guard by providing a means for indoor machine gun marksmanship. Satisfactory preliminary tests have shown that with slight modifications and at a small cost the present caliber .30 machine gun can be converted into a caliber .22 machine gun which functions in a manner similar to the caliber .30 weapon. It is hoped that in the near future at least one caliber .22 machine gun can be provided for each machine gun platoon for training purposes.

Railway Artillery Proves Value of Mobility

THE Coast Artillery has completed, with great success, one of the most significant railway artillery tactical exercises of recent years. The 52nd Coast Artillery (Railway) regiment, stationed at Fort Hancock, Sandy Hook, New Jersey, moved its railway guns from positions defending New York Harbor, a distance of 190 miles to Wildwood, New Jersey, and within less than twelve hours they were emplaced and ready to fire on ships entering Delaware Bay. The regiment consisted of fourteen officers and two hundred sixty-six enlisted men. The railway rolling stock of the regiment consisted of the following: 2 gun cars (8-inch guns), 2 gun cars (12-inch mortars), 4 ammunition cars (with ammunition), 1 radio car, 2 kitchen cars, 3 fire-control cars. The greater part of the personnel was moved by motor convoy.

This movement was part of an exercise carried out in the solution of a tactical and strategic problem prepared by Second Corps Area Headquarters at Governors Island.

New Type of Gas Mask

A SERIES of tests of a new type of gas mask, which has been in progress at Ft. Benning for some time under the supervision of the Infantry Board, was completed recently, when 112 soldiers of the 29th Infantry, wearing the new gas masks, engaged in baseball games and other sports to determine the field of vision afforded and to ascertain whether the device interfered with the physical exertions of its wearer. Previous tests had shown that the mask could be worn with comparative comfort and without interfering with normal activities.

The new mask is an experimental type designed by the Chemical Warfare Service upon suggestion of the Infantry, which desired to eliminate the necessity of individually fitting a mask to each soldier as is now done when the present issue type of mask is used. By a modification of the face piece and a new design of head harness, the experimental mask, which is termed the "universal face piece type," will fit more satisfactorily all sizes and shapes of faces, and will do away with the necessity of having five different sizes of masks, as at present.

Perfecting Long Range Artillery Fire

THE elaborate equipment recently installed by the Army Air Corps in the Douglas amphibian in Hawaii for the correction of long range artillery fire has proved equal to all expectations. Test flights and constant adjustment for the period of a month brought this apparatus to perfection. Intricate, yet rugged, these instruments cover all phases of artillery adjustment work perfectly. The splash of the shell is noted, distance from the target is computed, the vertical angle from the plane and its true bearings are determined. This information is radioed back to headquarters, and meanwhile three radio beams intersecting on the plane have fixed its position at sea absolutely. These separate groups of information are plotted together, and in a short time the necessary corrections are in the hands of the battery commander.

A camera records, by oblique photographs, the splash of every shot in the practices, and these pictures serve as a basis for study towards the elimination of the least possible error. With this information preliminary ranging shots will be greatly reduced in number and may even become entirely unnecessary.

Book Reviews

Weyer's Navy Handbook, 27th Edition, 1932. Published by Korvette Captain A. D. Weyer. Munich: J. F. Lehman. 1931. 13 Marks.

THE new edition of Weyer's work appears at an opportune time. The 27th edition of the Handbook—in the preceding year, due to economic conditions, only a supplement was issued—is most complete. It presents in pictures, sketches and silhouettes, the battleships of all countries as well as complete lists and summaries of all fleets and airplane carriers, and the equipment designs of the newest liners, battle cruisers and armed cruisers. It also contains the division of the German Government marine and an interesting marine-political review. The statistics on merchant marine, ocean traffic and ship building are valuable to all seafarers as well as to the government and merchant marine. These statistics are based on literature of the Hamburg-American line. It also contains numerous tables and explanations of war fleets, merchant ships, Morse signals, and tables of converson and distances, etc. The book by Weyer will continue to be a necessity to all who follow the statistics of navies and commercial shipping.

Transporting the A. E. F. in Western Europe: 1917-1919. By William J. Wilgus. New York: Columbia University Press. $12.50.

THE author of this book was a member of the Military Railway Commission to England and France; Director of Military Railways, A. E. F., and Deputy Director General of Transportation, A. E. F., consequently the authentic data at his command permit the presentation of an intensely interesting study.

Colonel Wilgus sets down what, in his opinion, were mistakes with the same freedom that he does what he considers real accomplishments of an infant organization, and this in a manner which makes the narrative highly entertaining. The style is quite simple, but at the same time filled with details, both graphical and statistical, which cannot fail to be of extreme interest to all who may at some time be called upon to function in a like situation.

The conclusions reached by Colonel Wilgus call for the profoundest consideration for the future, and they should be studied by all interested in the transportation of large bodies of men and mountainous supplies.

Between the Big Parades. By Franklin W. Ward. New York: Frederick M. Waterbury. 1932. $2.50.

THE publisher of this book Brig. Gen. Frederick M. Waterbury served for many years as Chief Ordnance Officer of the New York National Guard, and is well known in ordnance circles throughout the country.

The story may be classified as a postulation on group psychology. It is placed in a unique setting, namely, in the interval between a big parade that features the departure of an American division to the World War, and the big parade which celebrates its return to the United States.

It is an exceptionally human narrative, written with real spirit and zest, containing exploits and incidents mirrored with a lifelike reality. On the one hand it holds war aloft in all its flaming horror and tragedy, and on the other pictures many likable

TIMKEN
Tapered
ROLLER BEARINGS

for full anti-friction efficiency and radial-thrust load protection in motor trucks, tractors, tanks, gun carriages and all types of ordnance equipment and industrial machinery.

Timken Bearings carry all loads simultaneously—radial, thrust or both together in any combination.

For over 30 years the standard of the automotive industry.

The Timken Roller Bearing Co.
Canton, O.

A Sure Guide to Mechanical Excellence and Dependability

"Hoo-Hoo" Babbitt Metal

APPROVED BY THE
U. S. SHIPPING BOARD
For
TURBINE & DIESEL
ENGINE BEARINGS

Other Grades for Various Requirements

Write for Particulars

National Bearing Metals Corporation
St. Louis, Mo.

New York, N. Y.	Pittsburgh, Pa.
Jersey City, N. J.	Portsmouth, Va.
Meadville, Pa.	St. Paul, Minn.

"Between The Big Parades"

By

MAJ. GEN. FRANKLIN W. WARD

Between those big parades—that is, the going-to-war parade and the returning-home-parade, the book tells a thrilling story of the lives, fortunes, and misfortunes of soldier men during the actual hostilities abroad. The characters, from high ranking officers to high privates, pulsate with action, sometimes in laugh-evoking comedy and witticism, sometimes in tear-bringing pathos and tragedy.

AT LAST—A gripping war story of American soldiers in France by an American soldier who served with them throughout their service in the Great War.

It may be that this book will bring back, as in a mirror, memories long forgotten by Northerner. Southerner, Easterner and Westerner alike, who served in the Army during the Great War. Again after fifteen years the incidents, exploits and hardships of this story should be calmly read by the younger soldiers who have taken on where the older soldiers have left off, in order that they may have first-hand information as to what the Army will expect of them when, as Sgt. Duggin puts it in the story, they "are *let* for the war."

Price $2.50

Publisher, FREDERICK M. WATERBURY
70 East 45th Street
NEW YORK CITY

EVERDUR METAL

combines
these properties:

Strength of mild steel.
Corrosion-resistance of copper.
High ductility and fatigue limit.
Ready weldability

EVERDUR* can be rolled, drawn, spun, forged, pressed and cast . . . and can be worked either hot or cold. Investigate Everdur! Its desirable properties are resulting in an ever-increasing range of diversified application. *Reg. U. S. Pat. Off.

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Connecticut

characters among the officers and enlisted men whose nonchalance add to the entertainment of the reader. For instance, Striker Smith's letter to a French sweetheart in which he details his close association with General Pershing, is pure humor; while the story of the preparations for the King's review of the "Amoricans," is a classic metaphraze.

One discovers enough in Between the Big Parades to recognize its pages as one of the most interesting and withal informing war stories that has thus far been told by an American. The volume concludes with as admirable an example of war-veteran anthology. Irrespective of its literary charm it constitutes a worthy page of A. E. F. data.

Order of Battle of the United States Land Forces in the World War. Prepared in the Historical Section, Army War College. Washington: Government Printing Office. 1931. (For sale by the Superintendent of Documents, Washington, D. C. $1.50, Buckram).

THE preface to this valued reference work contains the following statement of the purpose and scope of the book. "The purpose of this work by the Historical Section of the Army War College is to present the essential facts of the participation of the land forces of the United States in the World War. Its deals with the command, composition, and operations of large units. This volume contains outline histories of the divisions which served in Europe during the war.

"Original sources, the majority of which are official papers of the War Department, form the basis. The source references are on file in the Historical Section of the Army War College. The command lists were compiled for this publication by The Adjutant General. The front lines of the divisions during battle are based primarily on a series of special studies by the American Battle Monuments Commission and an analysis by the Historical Section of the original material on file in the War Department.

"The lists of the attached and detached units are limited to the larger combat echelons; units smaller than a regiment or independent battalion are not shown unless they were engaged in combat. The dates of attachment or detachment usually appear, but in a number of cases only the actual battle participation while present, or detached, is recorded.

"Credit for participation in an operation is given a division from the time it entered corps reserve, provided the operation was in progress, or when it assumed command of a front without passing through corps reserve. Battle participation is shown as continuous when a division passed from a place in the line to corps reserve and then returned to the line; but any interruption in this sequence terminates the participation in that operation.

"The dates of sector occupation, when American troops were affiliated with Allied troops for training, are fixed by the entry into line of the first American unit and the departure from the line of the last American unit. However, when an American division entered a sector to relieve another organization or assumed command of a sector in which it was affiliated with Allied troops, the dates of the sector occupation are governed by the passing of command."

Benedict Arnold: Patriot and Traitor. By Oscar Sherwin. New York: The Century Co. $4.00.

THE life story of a man who, without exception, proved himself the most heroic and strenuous fighter revealed in the history of the early days of our War of Independence, but who finally committed the one black deed of treachery for which there can be no excuse. To Arnold must always be accorded the responsibility for whatever success we achieved between the days of Quebec and those of Saratoga. Unfortunately, it was also during this period that the Continental

Congress, due to the jealousy of various other actors in the drama and fostered by the ill will existing between the original states, took pains to heap insults upon Arnold and to slight him by promoting junior officers over him. This has led some to feel that his resentment over this treatment was justifiable, and he tried to resign his commission on several occasions, but was always persuaded not to do so. Certainly resentment cannot be justified to the extent of allowing base treachery to end his career in the glorious cause which he had made his own from the very beginning.

It is highly probable that while resentment smoldered in his mind, principally due to a shock to his impulsive pride, the real reason for his treachery was the ever-mounting debt which his mode of living and expensive entertaining entailed. Prevailing on his friend Washington, who had always maintained faith in Arnold in spite of the numerous attacks made on his character, to appoint him to the command of West Point, definitely proves that his treachery was not the matter of a moment, but had long been premeditated, and into the coils of which he had drawn his faithful and loving wife, Peggy Shippen. Failure, due to an accident of circumstances, brought his deed to naught and made the name of Arnold a burning symbol of baseness for all time.

These 363 pages give an excellent account of the part played by Arnold during and after the Revolutionary War, and they present a fascinating picture of his fellow officers, while the dramatic incidents of the period are realistically described. At times, however, the narrative is suddenly interrupted and its continuity suffers. In spite of this the biography never lacks interest and is recommended to every reader interested in historical characters.

Yorktown, 1781. By Colonel H. L. Landers, Historical Section, Army War College. 1931, U. S. Government Printing Office. $1.75.

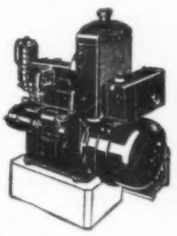
GEORGE WASHINGTON, resourceful and successful commander in chief of our ragged Continentals, is at his best in the remarkable series of land and sea operations that culminated in the surrender of Cornwallis at Yorktown. His masterful leadership in effecting the final concentration, involving the employment of French and American troops in harmonious cöperation with the French fleet under De Grasse, is ably presented in "Yorktown, 1781."

In preparing this book, the author has gone deeply into the most authoritative original sources, and has studied the ground with an appreciative eye for military values. His work displays not only professional military training, but a breadth of view which embraces the background of diplomatic maneuvers, in England and France, that had direct bearing on the outcome of the especially momentous struggle then going on in America.

BRIDGING THE WORK-GAP BETWEEN DUSK AND DAWN

Under the gleam of Kohler Light, a night crew speeds work on the approach to a giant railway bridge!

This actual night photograph illustrates how Kohler Electric Plants conquer the handicap of dark—as certainly and surely as the modern shovel and tractor aid in overcoming other obstacles of nature.



Kohler Electric Plants are compact, portable, operate without storage batteries, and hold a place of undisputed leadership in their field. Available from 800 watts to 25 K.V.A. capacity. Generating standard current at 110 or 220 volts, A.C. or D.C.

KOHLER OF KOHLER

Compliments

of

Briggs Manufacturing Co.

AUTOMOBILE BODIES

DETROIT, MICH.

Hotel Astor

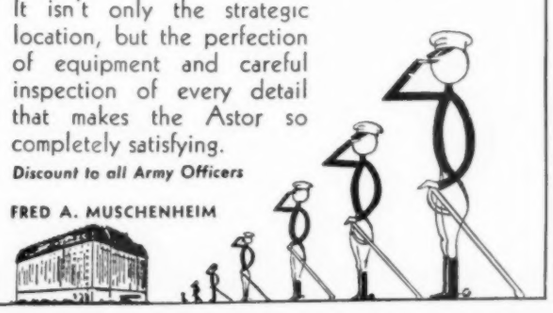
TIMES SQUARE NEW YORK CITY

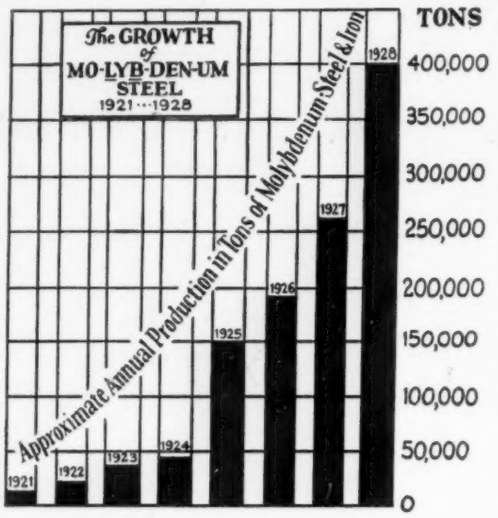
INSPECTION

It isn't only the strategic location, but the perfection of equipment and careful inspection of every detail that makes the Astor so completely satisfying.

Discount to all Army Officers

FRED A. MUSCHENHEIM





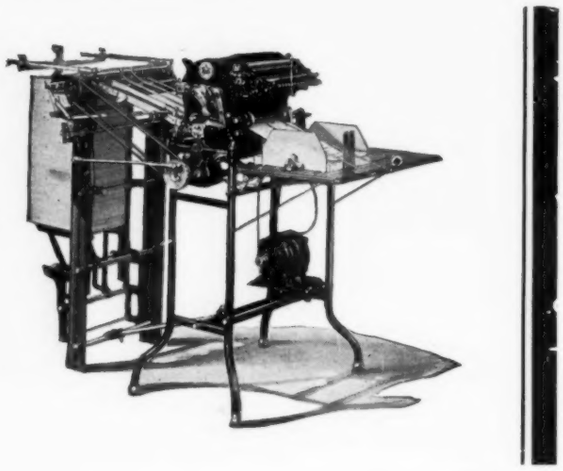
Mo - lyb - den - um

The American Alloy

The World's Supply is at Climax, Colo.

CLIMAX MOLYBDENUM COMPANY

295 Madison Ave. NEW YORK



Time and money saving models for printing, typewriting, composing, addressing and folding. Sales and service offices in fifty cities.

Almost every kind and size of business can use the Multigraph with profit. 49 banks out of a published list of the 68 largest in the United States use the Multigraph. That is the strongest endorsement of a business equipment that can be offered.

The

American Multigraph Sales Co.

CLEVELAND, OHIO

OVER 70% OF ALL DODGE TRUCKS built are in Service TODAY

Records on the road outweigh any claims ever made. ¶ The ability of Dodge Trucks to stand up and take it . . . year in and year out . . . is the biggest recommendation any product could ever have. ¶ There's a Dodge Truck for every purpose . . . from the surprisingly low-priced ½-ton, 1½- and 2-ton, to the equally fine values in heavy duty capacities up to 7½ tons payload. ¶ Let our dealers everywhere give you the latest data on the trucks that meet your needs.

UNITS OF

Union Carbide and Carbon Corp.

UCC

The Linde Air Products Company
Linde Oxygen, Nitrogen and other Atmospheric Gases

The Prest-O-Lite Company, Inc.
Prest-O-Lite Dissolved Acetylene

Oxweld Acetylene Company
Oxweld Oxy-Acetylene Welding and Cutting Apparatus

Union Carbide Sales Company
Union Carbide

National Carbon Company, Inc.
National Carbon Electrodes, Eveready Dry Cells and Flashlights

Electro Metallurgical Sales Corporation
Electromet Ferro-Alloys

Haynes Stellite Company
Haynes Stellite

Carbide and Carbon Chemicals Corporation
Organic Chemicals

Units of

UNION CARBIDE AND CARBON CORP.

General Offices: 30 East 42nd Street
New York, N. Y.